EXP. STA.
IMP. BUR.
- 7 MAY. 1924
ENTOM.

FORTY-FOURTH ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

NORTH CAROLINA DEPARTMENT OF AGRICULTURE

AND THE

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING

FOR THE

Fiscal Year Ending June 30, 1921
Statistical Report Year Ending December 1, 1921

FORTY-FOURTH ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

NORTH CAROLINA DEPARTMENT OF AGRICULTURE

AND THE

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING

FOR THE

Fiscal Year Ending June 30, 1921
Statistical Report Year Ending December 1, 1921

LETTER OF SUBMITTAL

Raleigh, N. C., June 30, 1921.

To His Excellency, Cameron Morrison,

Governor of North Carolina.

Sir:—I have the honor to submit herewith report of the operations of the Agricultural Experiment Station, conducted jointly by the North Carolina Department of Agriculture and the North Carolina State College of Agriculture and Engineering, for the year ended June 30, 1921. This work is under the immediate direction of the "Joint Committee for Agricultural Work," provided for in chapter 68 of the Public Laws of 1913, and amended by chapter 223 of the Public Laws of 1917, and the report is made in accordance with the requirements of the act of Congress, approved March 2, 1887, and known as the Hatch Act.

Very respectfully,

B. W. Kilgore,

Director.

TABLE OF CONTENTS

PAGE

Letter of Submittal 3

Staff of Workers 5

General Summary of the Work of the Station During the Year 7

Financial Report 15

Report of the Division of Agronomy 17

Report of the Division of Animal Industry 39

Report of the Division of Entomology 52

Report of the Division of Horticulture 60

Report of the Division of Plant Pathology and Bacteriology 67

Report of the Division of Markets and Rural Organization 69

Report on Drainage 79

BOARD OF AGRICULTURE

*W. A. Graham, *Chairman.*

F. P. Latham.....Belhaven
J. J. Harris.....Macon
*R. L. Woodard.....Pamlico
*Clarence Poe.....Raleigh
R. W. Scott.....Haw River
*A. T. McCallum.....Red Springs
*C. C. Wright.....Hunting Creek
W. B. McLelland.....Stony Point
H. Q. Alexander.....Matthews
A. Cannon.....Horse Shoe

BOARD OF TRUSTEES OF THE COLLEGE

*Governor Cameron Morrison, *Chairman.*

M. B. Stickley.....Concord
T. T. Ballenger.....Tryon
W. H. Williamson.....Raleigh
*O. L. Clark.....Clarkton
W. R. Bonsal.....Hamlet
D. R. Noland.....Crabtree
Claude B. Williams.....Elizabeth City
Clarence Poe.....Raleigh
*T. T. Thorne.....Rocky Mount
*C. W. Gold.....Greensboro
T. E. Vann.....Como
P. S. Boyd.....Mooresville
W. S. Lee.....Charlotte
C. F. Tomlinson.....High Point
*J. F. Diggs.....Rockingham
E. R. Johnson.....Currituck

*W. C. Riddick (President College), Raleigh.

STAFF OF THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION AND EXTENSION SERVICE

ADMINISTRATION

B. W. Kilgore.....Director of Experiment Station and Extension Service
C. B. Williams.....Vice-Director Experiment Station
F. E. Miller.....Assistant Director Branch Stations
J. M. Gray.....Assistant Director Extension
R. W. Green.....Agricultural Editor
A. F. Bowen.....Bursar
Miss S. D. Jones.....Bursar
Miss Mary S. Birdsong.....Secretary to Director
H. C. Evans.....Auditor and Executive Assistant

AGRONOMY

C. B. Williams.....Chief in Agronomy
W. F. Pate.....Soil Agronomist
S. K. Jackson.....Assistant in Soils
H. B. Mann.....Assistant in Soils
R. Y. Winters.....Plant Breeding Agronomist
S. W. Hill.....Assistant in Plant Breeding
P. H. Kime.....Assistant in Plant Breeding
G. M. Garren.....Assistant in Plant Breeding
†W. E. Hearn.....Soil Survey
†S. O. Perkins.....Assistant in Soil Survey
S. F. Davidson.....Assistant in Soil Survey
W. A. Davis.....Assistant in Soil Survey
†R. E. Devereux.....Assistant in Soil Survey
W. D. Lee.....Assistant in Soil Survey

A. R. Russell, Assistant in Field Experiments

CHEMISTRY

W. G. Haywood.....Fertilizer Chemist
F. W. Sherwood.....Assistant Chemist
L. M. Nixon.....Assistant Feed Chemist
E. S. Dewar.....Assistant Chemist
G. L. Arthur.....Assistant Chemist
B. C. Williams.....Assistant Chemist

Z. B. Bradford.....Assistant Chemist

ENTOMOLOGY

Franklin Sherman, Jr., Chief in Entomology
Z. P. Metcalf.....Entomologist
R. W. Leiby.....Assistant Entomologist
†C. L. Sams.....Bee-keeping
W. B. Mabee.....Extension Entomologist
C. S. Brimley.....Assistant Entomologist
T. B. Mitchell.....Assistant Entomologist

HORTICULTURE

C. D. Matthews, Chief Division of Horticulture
J. P. Pillsbury.....Horticulturist
L. H. Nelson.....Assistant Horticulturist
J. M. Dyer.....Assistant Horticulturist
W. W. Magill.....Extension Horticulturist

C. F. Williams.....Assistant Horticulturist

ANIMAL INDUSTRY

R. S. Curtis, Acting Chief in Animal Industry
Stanley Combes.....Dairy Experimenter
B. F. Kaupp, Poultry Investigator and Pathologist
†J. A. Arey.....Dairy Farming
†W. W. Shay.....Swine Extension
†A. G. Oliver.....Poultry Extension
John E. Ivey.....Asst. Poultry Investigations
†F. R. Farnham.....Assistant in Dairy Farming
†A. C. Kimrey.....Assistant in Dairy Farming
†D. R. Noland.....Assistant in Dairy Farming
†F. T. Peden.....Assistant in Beef Cattle
Earl Hostetler, Assistant in Beef Cattle and Swine
†George Evans.....Assistant in Sheep Extension

J. O. Halverson, Feed Chemist and Specialist in Nutrition

PLANT PATHOLOGY

F. A. WOLF.....Plant Pathologist S. G. LEHMAN.....Assistant in Bacteriology

DRAINAGE

F. O. BARTEL.....Drainage Engineer

MARKETS AND RURAL ORGANIZATION

B. F. BROWN.....Chief Division of Markets
GORRELL SHUMAKER.....Marketing Fruits and Vegetables
FRED. R. YODER.....Credit Unions
†P. H. HART.....Cotton Grading
T. B. PARKER.....Warehouse Organization
†J. P. BROWN.....Warehouse Inspection and Operation
J. M. WORKMAN.....Warehouse Construction
V. W. LEWIS.....Livestock Marketing
†FRANK PARKER.....Agricultural Statistician
WM. H. RHODES, JR.....Assistant Statistician
WM. D. JONES, JR.....Census Statistician

FARM MANAGEMENT

†J. M. JOHNSON.....Farm Management

BRANCH STATIONS

F. T. MEACHAM.....Assistant Director, Iredell Branch Station
R. E. CURRIN, JR.....Assistant Director Edgecombe Branch Station
E. G. MOSS.....Assistant Director, Granville Branch Station
S. C. CLAPP.....Assistant Director, Buncombe Branch Station
A. S. CLINE.....Assistant Director, Black Land Branch Station
CHAS. DEARING.....Assistant Director, Coastal Plain Station

FARM ENGINEERING

E. R. RANEY.....Farm Machinery Extension

FARM DEMONSTRATION WORK

C. R. HUDSON.....State Agent
H. H. B. MASK.....Assistant State Agent
E. S. MILLSAPS.....District Agent, Piedmont District
T. D. MCLEAN.....District Agent, Central District
O. F. MCCRARY.....District Agent, Northeastern District
E. W. GAITHER.....District Agent, Southeastern District

HOME DEMONSTRATION WORK

MRS. JANE S. MCKIMMON.....State Home Demonstration Agent
MISS MAUDE E. WALLACE.....Assistant State Home Demonstration Agent
MISS MARTHA CREIGHTON.....Piedmont District Agent
MRS. ESTELLE T. SMITH.....Eastern District Agent
MRS. CORNELIA C. MORRIS.....Central District Agent
MISS MAMIE SUE JONES.....Tidewater District Agent

---

*Member of Joint Committee for Agricultural Work.
†In cooperation with United States Department of Agriculture.

FORTY-FOURTH ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

For the Year Ended June 30, 1921

B. W. KILGORE, *Director*
F. E. MILLER, *Assistant Director Branch Stations*
R. W. GREEN, *Agricultural Editor*

The experimental work of the Central station at Raleigh and the six branch station farms has been more closely correlated during the year covered by this report. Considerable progress is reported in many lines of investigation, while practical applications of the results of experiments have been made through the Agricultural Extension Service.

Few other states have as close working arrangements between extension services and experiment stations as has North Carolina, and as a consequence this State is in a good position to make results of investigations immediately available to the farmers through the farm demonstration agents.

During the year members of the station staff have contributed a number of articles to scientific journals that reflect credit upon North Carolina, and help in the general advance of agricultural science. The work of Dr. Leiby, in connection with a study of polembryonic insects is particularly noteworthy in this connection.

CHANGES IN STAFF

Changes in staff since the last annual report include the following:

Resignations—H. B. Krausz, farm forester; J. H. Henley, specialist in credit unions; A. C. Foster, extension plant pathologist.

Appointments—W. W. Magill, extension horticulturist; Fred R. Yoder, specialist in rural credits; V. W. Lewis, specialist in livestock marketing; C. F. Williams, research assistant in horticulture.

The following paragraphs, under divisional headings, summarize the progress of experimental work during the year. More complete accounts of the work will be found in the reports of the chiefs of divisions.

AGRONOMY

Approximately one million acres have been surveyed and mapped during the last year in the soil survey work. The counties of Onslow and Cherokee have been finished and about one-half of Cumberland has been worked.

Investigations in soil fertility have been continued as in previous years and new projects begun on three different types of soil in different sections of the State to determine the soil deficiencies, plant-food constituents, and the most profitable kinds and amounts of fertilizers to use.

Experiments at the Black Land station have shown that for the successful production of crops it is absolutely necessary that the soil be furnished lime, except on newly cultivated land, where no fertilizer is now needed.

At the Mountain station results show that the use of phosphoric acid, nitrogen and lime produce better yields on both bottom and upland soils.

In tests at the Coastal Plain station it has been found that the use of fairly large quantities of fertilizer pays if other factors are favorable, and that nitrogen and lime are needed for the soil.

Results of rotation tests on the Edgecombe station show that the rotation of corn and cotton is no better than corn or cotton each grown continuously on the same land. A large percentage of nitrogen and potash is needed in the fertilizers used, and large applications of the fertilizer should be made.

Lime is essential to soils at Piedmont station for growing legumes, and the use of large quantities of nitrogen and phosphoric acid on general crops has been found necessary for best results. Decaying organic matter is valuable for increasing the crop-producing power of the soil.

Results of experiments on Central station have continued to bring out the importance of having more vegetable matter incorporated into the soil and making heavier applications of fertilizers on the best paying crops. The importance of lime and manure on leguminous crops has also been brought out.

Experiments on old and new land have been tried out at Reidsville, and it was found that fresh land is best for tobacco, while corn does much better on old land. Evidence shows that it is better to prime tobacco than to cut it. Application of phosphoric acid on fresh land is of great benefit to the growth of tobacco, and lime is also advantageous.

The outstanding features of tests at Oxford show that potash is absolutely essential for tobacco, for without it leaf-spot disease makes the tobacco almost worthless, and that dolomitic limestone increases the yield without decreasing the quality.

Another important fact brought out in tests is that by using magnesia the disease of "sand-drown" can be prevented. This can be done in a practical and inexpensive manner by using dolomitic limestone.

In cotton spacing tests the thickest spacing has produced the highest yield of seed cotton and lint per acre.

Seed-improvement work has been continued at the stations, and at the Central farm a seed house has been built for the storage and care of seeds.

ANIMAL INDUSTRY

It has been found that cattle can be wintered on orchard grass pasture at about half the cost of wintering them in barns. With horses and mules results show that the use of cotton seed meal cheapens the rations slightly, and does not effect the health of the animals.

The results of the work with lambs have shown that lambs can be dropped in December and January, and put on the market during March and April and command a premium because of their earliness.

In the feeding tests with poultry, experiments show that it requires 7.2 pounds of feed to produce one dozen eggs. Velvet bean meal produces a deleterious effect upon the birds. Artificial illumination proved successful in egg production, the hens under lights averaging 42.2 more eggs per year than the others. Tests conducted for three consecutive years showed that a flock of hens left on range averaged 71 eggs per year, while a flock on dry lot averaged 33 eggs per year.

Feed tests with hogs show that meat from hogs that have been fed on peanuts shrinks slightly less than that from hogs fed on corn and tankage. The carcass of a hog is composed of about 8 per cent bone.

ENTOMOLOGY

During the year 474 species of insects not heretofore known to occur in the State have been added to the list of species now on record, which makes a total of 6,221 included in the list.

Experiments in the use of dry dust poisons for control of cabbage worms have proven effective when given often, and are safe with ordinary precaution.

August is the most favorable month for cultivating infected lands to destroy cut-worm moths.

Investigations and experiments with household insects, such as cockroaches, bed-bugs, flees and weevils, have been conducted and valuable data obtained for fighting these pests.

The cowpea weevil experiments with air-slacked lime have shown that this is the most satisfactory method for controlling these pests, while experiments for controlling the tobacco flee beetle have proven that trap-bed methods are easiest and most effective.

The fumigation of mills has been simplified and put on a practical basis, thus effecting a great saving for the mills of the State.

HORTICULTURE

In the investigational work with pecans it has been found that the Schley, Stuart and Alley varieties are best suited for Eastern North Carolina. Work of improving and standardizing individual yields by bud selection has been started since it has been found that some trees of the same variety under identical conditions are heavy yielders

while others are poor producers, and the nuts of the different trees vary in size. In top-working the pecan trees, both grafting and budding should be used to secure best results.

None of the varieties of strawberries tested so far have shown themselves superior to the Klondike and Missionary as commercial varieties. Several of the varieties have been found to be valuable for home use.

As a result of investigations during the year, recommendations regarding the choice of varieties of Irish potatoes and cabbage for the western part of the State, the varieties of sweet potatoes for storage, and the most desirable methods to employ in the management of the storage house, can be given.

Investigational work with peaches and apples has been continued as in previous years.

PLANT PATHOLOGY AND BACTERIOLOGY

The work with rust-resistant wheat has been continued and although rust infection has been unusually severe throughout the State, the resistant varieties have remained remarkably free from rust.

More concentrated attention has been given to studies on the physiology of plant pathogenic bacteria, stressing mainly the hydrogen ion concentration, and should be completed during the coming year. Studies on Phoma blight of soybeans and treatment of seed-borne infections should also be completed during the year.

MARKETS AND RURAL ORGANIZATION

A number of successful coöperative marketing associations have been organized with the aid of this division this year, including the Mount Olive Truckers Association, the Scotland County Cantaloupe Association, which sold around 200,000 crates of cantaloupes, and a sweet potato marketing association in Nash and Edgecombe counties. All of these associations handled standardized products.

Considerable improvement has been made in grading and packing all fruits and vegetables as a result of the work of this division, especially Irish and sweet potatoes, strawberries, and apples. A careful study was made this year of grades for cucumbers and peaches with an idea of standardizing them next season.

The work of cotton classing and grading has made considerable progress this year, the total number of bales classed during the year being 64,246. Active interest is indicated in warehouse construction work by the numerous inquiries that have been received from all over the State. Two new warehouses having an aggregate capacity of 10,000 bales are in course of construction in the State.

No new credit unions were organized during the year but six are now being organized. Because of the bad crops and low prices received by farmers, the chief business of the unions this year has been borrowing

money from the banks for the members. Ten unions report that they were able to borrow money when it was impossible for the members to borrow as individual members.

FARM DRAINAGE

Farms in 17 counties were visited for the purpose of giving advice and assistance on tile drainage. Surveys and reports have been made for 12 farms, while stakes and grades for construction were given on 10 farms for the installation of approximately seven miles of tile.

Eleven examinations of a preliminary nature on proposed drainage districts covering an area of 52,450 acres were made during the year.

Increasing interest in soil erosion is shown by calls from farmers for assistance in locating terraces and giving demonstrations in terracing. More tiles were installed and a larger number of drainage districts, covering a larger acreage, were examined than last year.

BRANCH EXPERIMENT STATIONS

The location of the six branch experiment stations or field laboratories gives the subject-matter divisions opportunities to study agricultural problems of local importance. Each station represents one of the well-defined agricultural sections of the State in regard to soil type, climate and cultural practices. The stations serve as a base of agricultural information for their respective sections. With this arrangement, the Agronomy Division, for example, has an opportunity to investigate first hand the fertilizer requirements for the different farm crops on the principal soil types of the State; also to determine varieties, crop rotations and cultural methods best suited to the several localities. Likewise each group of workers, under the North Carolina Agricultural Experiment Station, has a chance to carry on their projects under conditions which are representative of the chief farming sections.

The information gained in this way serves as a guide in advising farm practices over the State. While the branch stations should lead their respective sections in agriculture, it is not their purpose to show neighbors how to run a farm, but rather to determine facts which are applicable to better farming.

Black Land Station—Wenona

This station is located in Washington County, at Wenona, on the Norfolk Southern Railroad. The soil is typical of that large area of peat soils which extends from Virginia down well into eastern North Carolina. This section is developing and shows great promise.

The station of two hundred acres was established in 1913, and since that time a great deal of the work has been done along the lines of development, and much information has been obtained regarding methods of clearing the cut-over land and drainage. At present 120 acres of the station lands are tile-drained and under cultivation.

The principal experiments now under way are lime and fertilizer tests, cultural practices, corn selection and improvement and trial tests with pasture mixtures, soybeans, cowpeas and truck crops. At present corn is the only crop tried that succeeded well the first year after the land was cleared. Lime is decidedly the first constituent needed by the soil after drainage for good crop results, and finely ground limestone is better than marl or hydrated lime.

Coastal Plain Station—Willard

This station is located in Pender County, one and one-half miles north of Willard on the Wilmington branch of the Atlantic Coast Line Railroad. The farm was established in 1905, and at that time contained 218 acres. In the spring of 1921 31 acres, bordering the property on the south, were purchased, which provides space for enlarging the experimental planting.

The purpose of the station is to study the agricultural problems of the coastal plain region, and to encourage diversification of farm crops. The farm has many visitors seeking information on various farm subjects, and particularly that of diversification since the boll weevil has appeared in some localities.

Results of the grape investigations show that the Muscadine is one of the safest fruit crops for the coastal plain region, and with this in view a four-acre planting of the Thomas, James and Scuppernong varieties, was made last spring to study first hand the value of this crop from the commercial standpoint, also to supply fruit for enlarging the grape utilization work.

The production of pedigreed seed has received special attention with the view of furnishing the farmers of this section with good seed of the proper varieties at a reasonable cost. Cleveland Big Boll cotton, Mammoth Yellow and Virginia soybeans, and Pee Dee No. 5 field corn were grown for seed distribution purposes this past year.

The outstanding experiments under way at this station are Muscadine grape investigations and utilization; dairy feeding tests and Jersey herd development work; poultry feeding tests; horticultural experiments, including tests with Irish potatoes and sweet potatoes; dewberries, strawberries, and observation garden planting; pecan, apple and peach variety studies; agronomy fertilization and rotation tests; and cotton anthracnose studies.

The progress and scope of the experimental work is covered in the reports of the subject-matter divisions.

Edgecombe Station—Kingsboro

Edgecombe County is one of our leading cotton and livestock counties, and the soil of this county is the very best for general agriculture. The experiment station is located two miles from Kingsboro on the old high-

way between Rocky Mount and Tarboro. The farm of 202 acres was established in 1902, and the soil is representative of the best land in the section.

The outstanding work on this station is the extensive agronomy fertilizer and rotation experiments, the seed selection and improvement of varieties, the seven-acre variety pecan orchard and the swine feeding experiments. A great deal of information has been obtained relative to these subjects, which is being generally used in this section. The general crop land is used for growing feed for the livestock work and producing improved seed.

The improvement and introduction of the Mexican Big Boll cotton in this section has given splendid results. Many of the leading farmers in Edgecombe County, and that vicinity, are now growing this variety with good results. Several of the large growers pooled their last year's crop and received a premium for their staple.

Mountain Station—Swannanoa

The mountain section of this State is especially adapted to fruit, truck crops, dairying, poultry and pasture crops, and the experiment station is conducted in view of assisting in the development of these industries. The experimental farm is located two miles northeast of Swannanoa, on the hard-surface road between Asheville and Black Mountain. The station was established in 1908 and consists of 305 acres. The soil is typical of the mountain region and responds readily to good handling.

At present the experimental work consists largely of agronomy fertilizer and rotation tests; seed improvement and selection; variety studies of soybeans, Irish potatoes and cabbage; truck crop production, and variety and pruning investigations with apples and home plantings of small fruits. Much valuable information has been secured along these lines, which is followed generally by the mountain farmers.

This section is especially suited to the poultry industry, in view of the ready market for all poultry products, and plans are under consideration for establishing an experimental poultry plant on the station during the coming year. The work of getting ready for the dairy project is already under way.

Piedmont Experiment Station—Statesville

The popularity of this station was emphasized by the attendance at the main farmers' picnic held last August, which numbered around 7,000 people. Several smaller meetings were held during the year, with good attendance, for the purpose of studying the work of the farm. The station is located one mile west of Statesville on the highway. The soil is typical of the Piedmont section, and is well suited to general farming. This experimental farm of 208 acres, was established in 1903 and has shown steady growth since that time.

The object of the station is to study agricultural problems of the Piedmont section, and to gather knowledge relative to better farming for that section. The major experiments of the station are a series of fertilizer and rotation tests with corn, cotton, oats, rye and wheat; seed improvement and selection work, principally with cotton, corn and wheat; variety studies with apples, peaches, pears, pecans, cherries and plums; feeding experiments with swine and sheep, and winter feeding of beef cattle. A series of pastures are planned that will provide grazing for hogs and sheep practically the year round, besides growing in rotation with pasture crops sufficient silage corn for feeding tests with beef cattle during the winter.

King cotton has proven to be well adapted to this section, and has been highly improved by selection. As a result, the station is growing this improved strain and distributing the seed to the farmers at a reasonable cost.

Tobacco Station—Oxford

This station is located in Granville County, one mile from the town of Oxford, and is well within the old tobacco belt. The station farm of 250 acres was established in 1913, and the work here has been carried on in coöperation with the Office of Tobacco Investigation, United States Department of Agriculture, Washington, D. C. The agricultural regions served by this station take in all the tobacco growing areas in North Carolina, although conditions at the station farm are more typical of the old tobacco belt.

The experimental work here is largely confined to tobacco and crops that work in rotation with tobacco. The outstanding tobacco experiments under way are fertilizer tests, variety tests, rotation systems for tobacco, tobacco after cowpeas, permanent tobacco seed beds, potash and lime experiments, and plant nutrition investigations, with continuous cropping, legume effects, and general crop effects.

The station has many visitors seeking information on tobacco culture. This past summer representatives of the various fertilizer manufacturers met at the station to study the results of the fertilizer and rotation experiments. This information has a great deal of influence on the kind and quantity of fertilizer used by the tobacco growers, particularly in the old belt.

The results of one experiment alone this year will mean a great saving to the tobacco growers. It was found that magnesium in the form of dolomitic limestone applied at the rate of 1,000 pounds per acre would prevent "sand-drown," a common tobacco disease. It was further shown that this disease can also be checked in the early stages by a side application of magnesium.

The progress and details of all experiments on the branch stations will be noted in the succeeding reports from the divisions.

PUBLICATIONS

One bulletin, No. 242, "The Green June Beetle or Fig-Eater," and supplement, have been issued this year with a total edition of 3,500 copies. About 1,950 of these were mailed. An annual report of 1,000 copies was issued and distributed.

Circular letters and post-cards have been multigraphed or mimeographed for the various divisions throughout the year totaling 31,642. Arrangement have been made whereby all letterheads are printed in this office on the multigraph and distributed to the divisions on request at a saving of approximately 60 per cent of the former costs.

The reports of the heads of divisions and the financial statement follow.

FINANCIAL REPORT

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In Account With the UNITED STATES APPROPRIATION, 1920-1921.

Dr.

	Hatch Fund	*Adams Fund*
To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1921, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)	$15,000.00	$15,000.00

Cr.

Salaries	$11,863.84	$13,949.17
Labor	3,136.16	828.77
Postage and stationery		81.75
Heat, light, water and power		105.00
Traveling expenses		35.31
Total	$15,000.00	$15,000.00

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In Account With FARM AND MISCELLANEOUS RECEIPTS.

Dr.

Receipts from other sources than the United States for the year ending June 30, 1921	$ 3,532.46
Borrowed from bank	3,750.00
Total	$ 7,282.46

SUPPLEMENTAL STATEMENT

Cr.

Labor	$ 720.48
Publications	6.00
Postage and stationery	330.72
Freight and express	156.63
Heat, light, water and power	412.65
Chemical and laboratory supplies	268.03
Seeds, plants, and sundry supplies	462.81
Fertilizers	574.42
Feeding stuffs	946.41
Library	62.62
Tools, machinery and appliances	297.11
Furniture and fixtures	88.50
Scientific apparatus and specimens	70.00
Traveling expenses	176.05
Contingent expenses	351.48
Buildings and land	1,438.06
Balance	920.49
Total	$ 7,282.46

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Experiment Station for the fiscal year ending June 30, 1921; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasury of the United States are shown to have been $30,000, and the corresponding disbursements $30,000, for all of which proper vouchers are on file, and have been by us examined and found correct, thus leaving nothing.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) C. F. TOMLINSON,
T. T. BALLENGER,
J. F. DIGGS,
Auditors.

(SEAL)

Attest: A. F. BOWEN, *Custodian.*

REPORT OF THE DIVISION OF AGRONOMY

To the Director: It is felt that, notwithstanding many disturbing factors, the agronomy experimental field work, in the main, has gone forward without any material interruption, except certain soil investigations carried on by our former soil chemist. With assurance from the Director, it is felt that financial conditions will be such during the coming spring so as to employ a soil chemist in the division to continue the soil investigations needed to be taken up in connection with our field work.

The work at present is conducted along the lines indicated below:

SOIL SURVEY

During the year the soil survey work which is being carried on in the State jointly by the Division of Agronomy and the Federal Bureau of Soils has gone forward as rapidly as is consistent with the best interest of the work. Since the last report, Onslow and Cherokee counties have been finished and about half of Cumberland County has been worked. Approximately 1,000,000 acres have been surveyed and mapped during the past year.

As every one must realize who is at all familiar with agricultural work, the soil survey properly conducted is fundamental to the most intelligent planning and conducting of work in soil fertility, crop adaptation, crop rotation and fertilization of crops.

It has been observed particularly during the past few years, the growing demand for the soil survey reports issued for the different counties. Not only are many farmers interested in these, but teachers and rural school teachers, settlers, lumbermen, highway engineers and others.

For the past six months our field force has been temporarily reduced materially.

MAINTAINING THE PRODUCTIVENESS OF OUR SOILS

Any system of farming that leaves the land poorer year after year, even if for the time being fair profits are being secured by the practice, is going to result disastrously in the long run on the prosperity of the people of the State. This being true, every precaution practicable should be exercised to protect and safeguard the fertility of our soils, because upon their continued productiveness will, to a large extent, be based our advancement.

It is much easier to maintain our soils than it will be to restore their productivity after they have once been exhausted. Earlier generations with their crude methods of tillage and lack of information with reference to the fundamental principles of soil fertility were able to abandon exhausted fields and emigrate to virgin regions to the west of us. With the increase of population this is not now possible to any great extent, and as the years go by and the density of population still

further increases, it will be less so. It is, therefore, encumbent upon us as a farming people in North Carolina to try to build up and maintain our soils in a highly productive state. For unless this is done, farming as a business cannot be expected to be remunerative enough to attract our young people.

To a large extent, the productivity of the soil will have to be maintained and built up by fairly simple means. The growth of leguminous crops, such as cowpeas, soybeans, and clovers is to play a very important part in this operation. On the average farm in North Carolina, as a matter of fact, this is the most economical and practical means to begin with after the land has been cleared and drained, where needed. It is not possible, as a general proposition, to increase the fertility of all the land on the average general farm, where feeds are not bought, by the use of livestock. Legumes when inoculated and properly cultivated are able to take a large amount of nitrogen from the illimitable supply of the air, and when these crops are turned into the soil they will carry this essential constituent of plant-food to the soil for succeeding crops. Of course, it is fallacious to conclude that because one is growing leguminous crops on his land, and is removing them year after year, that he is practicing a system that is going to build up the yielding power of his land. Such has never been done and cannot be done, because of the fact that there is a continual drain from the land of the available plant-food constituents, except possibly in the case of nitrogen, which may probably be ordinarily maintained at about the same amount. If one is to use legumes in a way, and it may be said in the only way, to increase the organic matter and nitrogen supply of his soil, a portion at least of the crops will have to find their way back into the soil. On very poor soils, deficient in organic matter, it will be necessary for best results, on an average, that most of the leguminous crops grown be plowed in for a time. Every progressive farmer, no doubt, in his experience has frequently observed that marked yields of crops have followed after the plowing in of a good growth of some leguminous crop, like cowpeas or soybeans, provided the turning under is done in such a way and at such a time as to permit of a thorough rotting of the material before the following crop is planted.

It could hardly be too strongly emphasized for the present year that larger acreages than heretofore should be devoted to the growing of such summer-growing legumes as cowpeas and soybeans. Two of the main crying needs of most of our soils in this State is for nitrogen and organic matter, and in order to supply these needs these crops must be grown more largely for soil-improving purposes only. Where they are cut and fed only about one in two and one-half tons of the organic matter contained in the crop will, under average conditions, find its way back to the soil in the manure, and ordinarily, not more than 50 to 60 per cent of the plant-food they contain will ever get back in the fields.

The mistake should not be made, however, in assuming for the average soil that one can depend solely upon the use of legumes for soil-building purposes. Phosphoric acid, generally, is a deficient constituent in North Carolina soils, and will have to be used where needed at the right time and in the right way in connection with the leguminous crops plowed in, but if most of the nitrogen needed by the non-leguminous crops, like cotton, corn and small grains, is supplied by a previous leguminous crop turned under, then the cost for the right kind of fertilizers will be much less per acre than it is at the present time, and thereby materially reducing the cost of producing the crop. In order to grow legumes and other crops in rotation with them satisfactorily, it will be necessary to use lime in a rational way on most of our soils.

When North Carolina farmers fully appreciate the importance of legumes, they will grow them in much greater amounts, and when used rationally their annual yields and profits should be materially increased.

SOIL FERTILITY INVESTIGATIONS IN OPERATION

During the year, soil fertility field investigations have been conducted mainly at the following places: Buncombe Farm, Swannanoa; Iredell Farm, Statesville; Edgecombe Farm, Rocky Mount; Washington Farm, Wenona; Pender Farm, Willard; Granville Farm, Oxford.

For the study of the plant-food requirements of the leading types of soil in different parts of the State, the following tests have been continued during the year on the soils and at the places indicated:

For Mountain Section

Porter's Loam at Swannanoa, Toxaway Loam at Swannanoa.

For Piedmont Section

Wilkes Sandy Loam at McLeansville, Davidson Clay Loam at Linwood, Mecklenburg Clay Loam at Concord, Cecil Clay Loam at Statesville, Durham Sandy Loam at Oxford.

For Coastal Plain Section

Norfolk Fine Sandy Loam at Rocky Mount, Portsmouth Fine Sandy Loam at Pamlico, Muck at Moyock, Norfolk Fine Sandy Loam at Willard.

New Soil Fertility Investigations

During the year the following work has been started, in each case in coöperation with the Federal Bureau of Plant Industry, to determine the soil deficiencies; best proportion of plant-food constituents; best carriers of and amounts of potash and nitrogen; and the most profitable amounts of fertilizers to use per acre for different crops: On Ruston

Sandy Loam on the farm of S. J. Currie, near Fayetteville; on Georgeville Sandy Loam on the farm of R. F. Lynch, near Ashboro; on Portsmouth Sandy Loam on the Bradham farm, near Newton.

MISCELLANEOUS EXPERIMENTS

In Wilkes County.—Experiments have been started to study the effects of applications of sulphur, gypsum and lime on alfalfa grown on a Cecil Clay soil.

In Anson County.—Experiments have been put out on one of the slatey soils of this county to determine if the growth and turning under of cowpeas with and without lime will improve or hurt the soil. It is claimed by some of the best farmers of that section that the turning under of a crop of cowpeas will materially reduce a crop of cotton following.

In Washington County.—At the Wenona Farm, experiments were started this year to determine the value of different methods of preparing and cultivating the soil for corn, soybeans, cowpeas, sorghum, oats, sudan grass and rye. Also experiments have been started at this place to determine the grasses and grass mixtures best suited to the black-land soils of the eastern portion of the State.

In Wake and Edgecombe Counties.—Tests to determine the effects applications of lime, sulphur and gypsum will have upon the quality of peanuts.

In Martin County.—Experiments on rather large areas were started this year on the farm of B. B. Everett, at Palmyra, to determine the value of the use of gypsum on peanuts used in different quantities and applied at different dates.

SOME RESULTS OF FERTILIZER EXPERIMENTS AT DIFFERENT FARMS

At Washington Farm.—Results have been secured on the peaty soils of this farm showing quite conclusively, after good drainage has been established, that lime in some form is absolutely necessary for the successful production of crops. Three forms of lime have been studied. Both burnt lime and ground limestone have continued to give better results than marl. Applied at the rate of one ton per acre, burnt lime has shown up best. This is partially explained by the finer condition and hence quicker action of burnt lime.

So far, neither nitrogen, phosphoric acid, nor potash has given much benefit on these soils with corn.

Stable manure seems to increase the growth of crab-grass, which chokes out the native grasses to a great extent.

Deep plowing and planting on a ridge has given strong indications that the practice of merely disking and planting and cultivating on the level should be changed. Ridging appears to be necessary for these

soils for them to give their best returns in their present stage of decomposition.

Due to insect ravages and crop diseases, it seems imperative that a suitable crop rotation be worked out for these black-land soils to aid in the elimination of some of the losses from these causes.

At Pender Farm.—Drainage is a big problem at this farm due to large annual rainfalls with heavy rains at intervals.

For the successful growing of crops the addition of both nitrogen and phosphoric acid have been found to be essential. Potash, too, has shown to advantage.

In the crop rotations practiced, lime has given large returns, and in order to grow leguminous crops to supply both nitrogen and organic matter to the soil, lime is a big factor.

Acid phosphate appears to be a more efficient carrier of phosphoric acid than either basic slag or soft phosphate on the soils of this farm.

At Edgecombe Farm.—The main fertilizer tests at this farm consist of fields A, B and C, on which is used a three-year rotation of corn, cotton and peanuts with cover crops every year. In these tests and on this type of soil, nitrogen and phosphoric acid and potash all should ordinarily be supplied for best paying crop yields.

On field A, an application of nitrogen and potash has paid better on an average than a complete fertilizer. With larger amounts of nitrogen and potash, phosphoric acid begins to show up. The results show as a whole that the formulas used by farmers are frequently not the best for most economical gains. More nitrogen and potash should be used, with the phosphoric acid remaining about the same.

In the rotation tests on this farm, the results show that corn every year and cotton every year is better than a rotation of corn and cotton, where fertilizer is used in all cases and no leguminous cover crop is grown. When legumes are used in the rotation and another crop of oats added, better yields of all crops are secured.

The use of rock phosphate has not given as good results in the main fertilizer tests as has the use of acid phosphate.

In the study of different carriers of nitrogen, nitrate of soda still leads with ammonium sulphate coming second in efficiency, when measured by crop yields. All the carriers of organic nitrogen show from their lesser yields that suitable inorganic forms give greater efficiency.

A test to determine the effect of winter-killing on crimson clover, using seed from foreign and native sources, did not show any decided difference in the yields from seed from different sources.

Iredell Farm.—On the type of soils of this farm the evidence is still conclusive that phosphoric acid and nitrogen are the controlling plant-food constituents for better crop yields. Lime is now giving good results and the yield of crops indicates that if more organic materials

were incorporated in the soils, which could be secured from the use of legumes and lime, the capacity of the soil to make larger crops would be increased by the increased efficiency of fertilizers added.

In rotation tests, the results show that corn every year and wheat every year with fertilizer is just as good as a two-year rotation of corn and wheat with fertilizers; and that when legumes are added in the rotation, such as red clover, cowpeas or soybeans, much better crop yields are secured.

In the study of different forms of nitrogen carriers, nitrate of soda and ammonium sulphate have given greater efficiency uniformly from the beginning. No noticeable residual effect is manifested in plats receiving organic carriers of nitrogen over those on which the inorganic carriers were used.

In the regular fertilizer experiments, rock phosphate has not shown as great efficiency as has the use of acid phosphate. In a test where rock phosphate was used in amounts varying from 500 to 4,000 pounds, a complete fertilizer has shown up better in all cases with corn and wheat, except in the case where 4,000 pounds of rock phosphate were used. This latter plat seemed a litle more fertile from the beginning and has kept up so.

In the spring of 1919 a test was started at this farm to determine the value of soft phosphate against acid phosphate. Up to this time, acid phosphate has given greater yields of both cotton and corn.

Buncombe Farm.—In the regular fertilizer experiments at the Buncombe Farm, phosphoric acid, nitrogen and lime seem to be the controlling factors for better yields on both bottom and upland soils.

Acid phosphate, with stable manure and with legumes, continues to show up as a more efficient source of phosphoric acid than does finely ground phosphate rock.

The use of lime is continuing to show up on the soils of this farm to good advantage, especially when legumes enter into the rotations.

In 1918 an experiment was begun to compare the availability of acid phosphate, soft phosphate and basic slag, with limestone and complete fertilizer. The results so far are not conclusive.

Central Farm.—The results of the experiments here have continued to bring out the importance of having more vegetable matter incorporated into the soil so that crops will be enabled to take best advantage of the applications of plant-food. Nitrogen and phosphoric acid are the main limiting plant-food constituents, while potash is of little importance for increased production until after nitrogen and phosphoric acid have been applied in goodly amounts.

An experiment has been conducted to determine the value of phospho-germ as a fertilizer. The results have shown that this material has but little value as a fertilizing material on the soils of this farm during the first year or so. Where we have had a good crop of

soybeans, after harvesting the seed, plowed into the soil, it was quite noticeable this past dry season the land remained in better tilth and worked better all the year.

With fields A and B at this farm, which had been grown continuously in cotton and corn for a number of years, the yields continued to decline from all the different fertilizer treatments used up to 1918, when manure was added uniformly over all the plats at the rate of seven tons per acre. The west half of all plats was then limed at the rate of one ton of ground limestone per acre, except those plats in the regular fertilizer series which had previously received lime, which, by the extra application, now receive an application of two tons of limestone on the west end every three years. Two crops of soybeans have now been grown and turned in on all the plats. The yields have been increased of both soybeans and money crops on both ends of the plats, and remarkably so on the limed end, over what was secured from them before the lime and manure were added. The results from these experiments have brought out the almost impossibility of building up some of our very poor Piedmont soils by sole dependence upon the growth of leguminous crops until after the soil has been enlivened by at least a small application of stable manure. In the Piedmont region of the State many of these soils are so dead, apparently, that legumes fail to grow satisfactorily on them, even under the most favorable weather conditions, until after the soil is helped in the way indicated above. The use of fertilizers alone cannot be depended upon to build up their productivity when such crops as corn and cotton are solely grown on them.

SOME PRACTICAL CONCLUSIONS FROM SOIL FERTILITY WORK

At Buncombe Farm.—(1) The proper use of lime on both upland and bottom-land soils pays well. (2) The use of rotations including red clover and other suitable legumes are wise for best results. (3) The use of larger quantities of fertilizers, including a larger percentage of phosphates than is commonly used by farmers is usually profitable.

At Washington Farm.—(1) Fertilizers are not now needed nor are they profitable with ordinary crops on newly cultivated land. (2) Lime is very necessary for the growth of crops to advantage. It should be finely ground and be applied every other year at the rate of about two tons per acre until the excessive acidity of these two soils is destroyed.

At Pender Farm.—(1) The use of nitrogen in available forms is a big factor in the most economic growth of crops. (2) The use of fairly large quantities of fertilizer will pay, if other factors are favorable for crop production. (3) Lime is necessary for growing soil-improving crops and the building up of these soils.

At Edgecombe Farm.—(1) The use of larger applications of fertilizers, including a larger percentage of nitrogen and potash in the

mixtures than is commonly used. (2) Nitrogen in some soluble form is one of the first limiting factors in crop growth. (3) A rotation of corn and cotton has been found to be no better than corn or cotton grown each continuously on the same land. (4) Sludge has been found to be a poor carrier of nitrogen for crops. (5) Acid phosphate has been found to be more efficient than other carriers of phosphoric acid thus far tried out.

At Iredell Farm.—(1) The use of larger quantities of nitrogen and phosphoric acid on general crops has been found to be necessary for best results. (2) Lime became essential if legumes are to be grown successfully. (3) Rotations that include soil-improving crops have shown the value of decaying organic matter on crop-producing power of the soil. (4) When rock phosphate is used, larger applications at long intervals is recommended.

At Central Farm.—(1) The value of incorporating decaying organic matter in these soils is of prime importance. (2) The great value of the use of lime on legumes has been demonstrated. (3) Heavier applications of fertilizing materials for the best paying crops is advisable. (4) Lespedeza has been found not to be a suitable hay crop in this section of the State. (5) Phospho-germ has shown up of little value on these soils as a fertilizing material compared with the ordinary fertilizing materials. (6) Crimson clover, without lime, has been found to be a failure on these soils. (7) A proper system of crop rotation including legumes will pay.

TOBACCO EXPERIMENTS

Quite extensive work with tobacco is being conducted at Reidsville and at Oxford in coöperation with the Office of Tobacco Investigations of the United States Department of Agriculture. Below is given a brief resume of this work:

At Reidsville.—During the year there has been sustained a small reduction in the experimental work with tobacco being carried on at this farm, mainly due to the fact that the superintendent had to take on outside additional work temporarily in connection with the standardization of tobacco grades. The reduction consisted of omission of the test of the relative value of harvesting by priming, as compared with harvesting by taking off the entire plant at one time by cutting off the stalks. Sufficient evidence seems, however, to have been accumulated both here and at Oxford, at least for the present, to establish the superiority of priming over cutting. Even in the old belt, farmers now quite generally have taken up priming and are in a position to judge for themselves as to the merits of the two methods.

The study of general fertilizer tests, too, has been discontinued and a bulletin is now in process of preparation embodying the results of these tests covering a period of ten years.

Both of these changes, however, have been brought about in accordance with an already approved plan for changing the work gradually in the general nutrition scheme involving crop effects on the soil as well as mere fertilizer effects. An important feature of this work here, and which is not duplicated elsewhere so far as we are aware, is the conducting of these nutrition experiments on freshly cleared hardwood land in duplicate with the same experiments on old land of similar character. The primary observation of this work is the striking superiority of tobacco on the fresh as compared with the old land, while the exact reverse of this is true in respect to corn, corn being much better on the old land.

The second noteworthy observation of the results of this experiment during the past year is the decided benefit that comes from an application of phosphoric acid on the fresh land, with corn showing the deficiency even more than the tobacco. It was also observed that lime gave a better growth of both tobacco and corn on the fresh land as well as on the old land, although this benefit was not quite as decided as in 1920, the difference perhaps being chiefly due to the unusually dry season; lack of moisture apparently being the chief factor limiting the plant growth this past year.

A further observation, not entirely expected, was the clearly discernible characteristic potash deficiency on the plats receiving no potash, even on the fresh land. As has been noted in previous years where experiments of this kind were conducted on old land the small grain (wheat, oats and rye) were considerably better on the fresh land where they succeeded tobacco than where they followed corn. Additional evidence of the depleting effects of corn, as compared with tobacco, was shown on Field 5 (old land) continuing the plats from the third successive year continuously in tobacco, continuously in corn, and in tobacco in rotation with corn. Nothing was more outstanding in the experiment here than the marked superiority of the growth of tobacco on the plats for the third successive year in tobacco as compared with the tobacco grown on the plats where corn intervened in 1920.

Another observation on this particular set of plats was the relative deterioration of the lime plats. In 1919 and 1920, lime in addition to a complete fertilizer gave a very noticeable improvement in the yield. This year the effect of lime in improving the yield was not so noticeable. Dry weather or some other factor may have had a marked influence. But the presumption seems reasonable that lime gave a better yield at first because it hastened the decay and nitrification of the soil's accumulated store of organic material. But in this particular system of continuous planting to an intercultivated crop without provision for restoring the consumed organic matter, the soil even in this short time under the accelerating influence of the lime has apparently become relatively poorer than the unlimed plats.

In addition to these tests distinctively referred to as nutrition experiments, the plan is to take up from time to time specially planned experiments on special problems important to tobacco culture. One of the most important of these special problems at the present time is in regard to the form of potash to use both as affecting the yield and quality of tobacco, and also their influence on certain diseases to which tobacco is subject, especially "sand-drown," ordinary leaf-spot, and wild-fire. Sufficient experimental evidence has been obtained in the last few years to entirely reopen this question as to the form of potash preferable to use for the tobacco crop. Due to the unusually dry season, the potash experiments did not yield as remarkable results as last year. "Sand-drown" was scarcely in evidence at all in this section (the first time in several years), so the experiment showed almost nothing in regard to them, but there was, nevertheless, a very noticeable superiority of growth where the muriate of potash, kainit and manure salts were applied over the use of sulphate of potash. Magnesia, which was expected to exert an important influence in preventing "sand-drown" did not, of course, give any convincing results this year, since practically no "sand-drown" occurred on any of the fields.

At Oxford.—In the regular fertilizer tests there are 36 plats of $\frac{1}{20}$-acre each, used in testing out the various sources of nitrogen, phosphoric acid and potash, and combinations of these various sources, both as to quality and amounts. One-half of these plats are limed at the rate of one ton per acre, broadcast of dolomitic limestone. The outstanding features of these tests are that potash is absolutely essential for tobacco, for without it the common disease of leaf-spot is so bad that the tobacco is practically worthless. Secondly, dolomitic limestone increased the yield on practically all the plats without decreasing quality.

Another series of 10 plats known as special potash plats are also being run. Under these plats the same amounts of nitrogen and phosphoric acid are used on all plats with varying amounts of potash from 12, 24, 36 and 80 pounds of actual potash (K_2O) per acre; also two check plats are being run with no potash used. Both muriate and sulphate of potash are being used in the comparisons. The outstanding result of these experiments at the present time is that muriate of potash gives a larger yield of tobacco which for the past four years has been selling for as much per pound as the tobacco grown from the sulphate of potash. However, there is yet some question about the use of muriate too largely, as it does injure the burning quality. One-half of these plats were limed.

In Variety Tests.—A large number of so-called varieties have been tested out in an effort to classify these types. So far, we have tried out about one hundred different varieties, some of which are distinct types or varieties, while a large number of the so-called varieties are of the same general type only under a different name, possibly named for the man who grew this tobacco successfully and sold it for a high price.

We have made a few crosses and have some hybrids which show some promise. However, this takes time.

In the tests of rotation systems for tobacco several rotations have been practiced, viz.: a two-, a three-, and a four-year rotation. The three-year rotation, as follows, may prove to be most generally popular, viz.:

First year.—Tobacco, followed by oats, or wheat, or oats and vetch for hay.

Second year.—Oats or wheat, followed by cowpeas or soybeans for hay, or plowed under; then seeded to Abruzzi rye for seed.

Third year.—Rye harvested for seed. Cut the rye as high as possible to leave as much stubble on the land as can be done; then let lay fallow all summer and plow deep for tobacco in the fall.

A four-year rotation can be used with corn and grasses in the plans with good results. Where tobacco land is limited, a two-year rotation consisting of tobacco and some small grain can be used.

A test of tobacco after cowpeas is being run. This is a two-year rotation with tobacco first year, followed by fall-sown oats, cut for hay or seed; then the land is seeded to cowpeas or soybeans, broadcast and plowed under, after which the land is seeded to rye as a cover crop. The object of this experiment is to see if the nitrogen secured by the cowpeas and turned back into the soil would grow tobacco with enough quality to justify the attempt. During the first four years the tobacco on this plat was topped low and harvested by cutting, and the quality was very poor. Notwithstanding that, no nitrogen from commercial fertilizer was used, and the phosphoric acid and potash were increased, running as high on some of the plats as 1,200 pounds of 16 per cent acid phosphate and 200 pounds of 50 per cent sulphate of potash per acre. When the tobacco was topped high and planted 24 inches in the drill in four-foot rows and harvested by priming the leaves off as they matured, tobacco of average good quality was secured with a yield ranging from 800 to 1,100 pounds per acre.

In permanent tobacco seed-bed tests the object is to maintain a permanent tobacco seed bed, located conveniently near the house of the farmer, if possible, and keep it free from disease by sterilizing each year with live steam. This has been found to be entirely practical as well as economical. If the farmer has a portable steam boiler which he can use for steaming the bed, the plants grow faster, are more uniform in size and are healthier. The cost, when coal is used, is about half what it would be if burned by open fires with wood. However, a very large number of farmers do not burn their beds at all, but get up new beds each year. This is all right as long as suitable land is available, and they can be located so they will be free from any fungus diseases which are so common in tobacco beds.

The potash and lime experiments consist of 18 plats, six major plats, fertilized with the same amount of nitrogen and phosphoric acid from

the same sources, but under each of these plats, different kinds of potash are used, viz.: German sulphate, Nebraska sulphate, German muriate, Trona muriate, manure salts and kainit. These plats were divided into sections A, B and C. Under A, ground limestone derived from practically pure calvite was used. Under B, no limestone was used. Under C, dolomitic limestone was applied. The limestone was applied in the drill at the rate of 1,000 pounds per acre. The object of this experiment was to control a disease which is commonly known as "sand-drown." After working with this disease for three or four years, we were led to believe magnesia would prevent it; therefore, we found in field tests that this was absolutely true, and this can be done in a practical and inexpensive manner by using dolomitic limestone which contains from 20 to 35 per cent of magnesium carbonate. The results of this experiment are undoubtedly of the most far-reaching importance of anything accomplished on the tobacco stations for the past few years, and we believe will mean millions of dollars to the tobacco farmers of this State alone. Practically all of the larger fertilizer companies sent representatives to Oxford last summer to observe the results, and a number of them are now making plans to use magnesia in some form in their tobacco fertilizers next year.

The plant nutrition investigations are planned to study crops and legume effects. The part dealing with crop effects consists of two fields of 45 plats each, a total of 90 plats, on which is planted the first year tobacco, cotton and corn, using the same fertilizer for each crop. The second year wheat, oats and rye are sown on these plats. The plats are so arranged that wheat follows cotton, corn and tobacco; also the same is true of oats and rye as with wheat. During the rotation, each of the major crops—cotton, corn and tobacco—follow each of the small grain plats. By this means accurate data can be obtained as to the crop effect of each of these six crops. Some good results are being secured.

The part of the experiment dealing with legume effects consists of two fields of 63 plats each, giving a total of 126 plats of $\frac{1}{40}$-acre each. The object of this experiment is to find out by actual field tests the relative value of the various annual legumes, such as crimson clover, hairy vetch, cowpeas and soybeans, as compared with grass and fallow plats. These plats are planted to tobacco, cotton and corn without any commercial nitrogen being added in the fertilizers, but phosphoric acid and potash are used. The same amount is used under all plats except the check, to which a complete fertilizer is added. After the cotton, corn and tobacco are harvested, wheat, oats and rye are planted in a similar manner as under the crop effect section. By this means we have cotton, corn and tobacco following the legume crops and the grass crop; thereby enabling us to study the relative values of the legumes on all the main crops, also the crop effect and residual effect on the small grain crops. This is an extremely interesting experiment and one, we believe, that will be of considerable value to agriculture.

A continuous cropping experiment is being run. In this experiment one field of 15 plats is used, on which tobacco, cotton and corn are cropped each year. One series of plats tobacco follows tobacco each year; cotton follows cotton; and corn follows corn; and then a rotation of tobacco follows cotton and corn, and vice versa for each of the crops. This is used as a check against both sections of the main plant nutrition experiments. We have already found that it is dangerous to have tobacco follow tobacco, especially in territory where "tobacco wilt" might be expected—as on the plats where tobacco has been cropped continuously for five or six years 50 to 60 per cent of it was affected with the wilt. In adjoining plats, where a two-year rotation is being followed with only a space of a few feet apart, there was no wilt. Besides the danger of plant diseases, the soil fertility is being diminished.

PROFITABLENESS OF FERTILIZING CORN GROWN ON UPLAND AND BOTTOM LAND IN MOUNTAINS

For many years the Division of Agronomy has conducted fertilizer experiments on both upland and mountain soils. As a result of these experiments it has been found that the fertilization of corn will pay a profit if the proper kinds and amounts are used. In fact, without the proper use of commercial fertilizers or farm manures, the growth of this crop will seldom be profitable with most poor mountain soils under normal market conditions. What this amount and proportion should be is given in the resume below:

Toxaway Loam (Bottom soil).—(1) With only two fertilizer constituents used phosphoric acid combined with potash gave the greatest increase in bushels of corn and also the greatest net returns. When nitrogen and potash were used only a small gain was made and just 43 cents over what the fertilizer cost, while nitrogen and phosphoric acid gave an increase of 17.6 bushels of corn over the untreated plats showing a profit of $17.34. With the use of a complete fertilizer (nitrogen, phosphoric acid and potash) an increase of 28.3 bushels was secured, making a gain of $29.76. This is $4.78 less than what was obtained with a mixture of phosphoric acid and potash. Taking into consideration both increase in yield obtained and the value of the increase, it is very evident that phosphoric acid is the dominant or controlling constituent of plant food for increasing the yields and profits in corn growing on this type of soil.

(2) Lime, when used alone, has given fairly large increases each year on the untreated plats with a corresponding net return, and in conjunction with a complete fertilizer larger yields and returns have been secured than on any other plats except those on which the fertilizer application was increased from 400 pounds per acre to 600 and 800 pounds per acre, respectively.

Under the conditions of the experiment, the results show that for corn grown on this type of soil, lime may be used at a profit alone and with a much greater profit when applied in conjunction with a complete fertilizer.

(3) The amount of nitrogen used in the normal fertilizer (400 pounds per acre applied in these experiments was 3 per cent or 12 pounds per acre. This amount was varied so as to give 6 and 24 pounds of nitrogen per acre. The yield and value of both corn and stover was decreased as the size of the application of nitrogen was increased. In fact, the use of nitrogen in any amount did not give as great an increase over the no-treatment plat as did the combination of phosphoric acid and potash. The net returns were, too, not as large from the former.

Until other crop-producing factors are controlled the use of nitrogen is not profitable for growing corn on this type of soil.

(4) The amount of phosphoric acid in the normal fertilizer (400 pounds per acre) was 7 per cent, which is equivalent to 28 pounds per acre. This quantity was varied to include 14 and 56 pounds of phosphoric acid per acre with normal amounts of nitrogen and potash.

The yield of both grain and straw increased over the unfertilized plats as the amount of phosphoric acid was increased. The net returns secured per acre were $15.26 when 14 pounds of phosphoric acid were used; $29.26 with the use of 28 pounds; and $33.57 when 56 pounds of phosphoric acid were used. Under the conditions of the experiment it is evident that when normal quantities of nitrogen and potash are applied, 56 pounds of phosphoric acid is the most profitable amount to use.

(5) The amount of potash in the normal fertilizer (400 pounds per acre) was 1½ per cent, which is equivalent to 6 pounds per acre. This amount was varied so as to include 3 and 12 pounds of potash per acre with normal amounts of nitrogen and phosphoric acid. The results show that 6 pounds of potash is sufficient for corn on this type of soil when nitrogen and potash in normal amounts are used with it.

(6) Varying the amounts of the normal fertilizer applications (400 pounds per acre) from 200 to 600 and 800 pounds per acre gave progressively increased yields and profits as the quantity of fertilizer was increased. The results of the applications after deducting the cost of the fertilizer show the following net profits:

200 pounds of fertilizer per acre gave a profit of	$21.01
400 pounds of fertilizer per acre gave a profit of	29.76
600 pounds of fertilizer per acre gave a profit of	42.31
800 pounds of fertilizer per acre gave a profit of	45.69

Putting this in a slightly different way, the first 200 pounds of fertilizer yielded a net profit of $10.51 for each 100 pounds of fertilizer used; the application of 400 pounds of fertilizer yielded $7.44 per 100 pounds; while 600 pounds made $7.05 profit per 100 pounds, and 800 pounds yielded $5.71 profit per 100 pounds of fertilizer used.

(7) From the chemical analyses of the various bottom-land soils in the western part of the State the indications are that these results will apply generally to these soils.

(8) In the production of corn on average bottom-land soils of the character of this, taking all the results secured as a whole, it is recommended that on well prepared seed beds that at least 600 pounds of fertilizer per acre be used, analyzing 10 per cent phosphoric acid, 1½ to 2 per cent nitrogen, and 1 per cent potash.

It should be the plan of every farmer to reduce the necessity for the use of nitrogen in the fertilizers purchased. This can be done to some extent at least by the growing and plowing in of leguminous crops and crop residues grown in rotation with corn.

Porter's Loam (Upland soil).—(1) Nitrogen, when used alone in normal amounts (12 pounds per acre), did not produce enough increase over the unfertilized plat to pay for the fertilizer applied.

(2) With the use of a normal amount of phosphoric acid (28 pounds per acre) alone, an increase in yield of corn was secured of 14.5 bushels, having a net value of $15.82. This yield and profit is greater by far than when either nitrogen or potash were used alone. It is evident from these results that phosphoric acid is the limiting plant-food factor to be first applied for the production of corn on this type of soil.

(3) With a normal amount of potash (6 pounds per acre) a net profit of $7.36 was secured.

(4) With the use of a mixture carrying normal amounts of nitrogen and phosphoric acid, and no potash, after paying for the fertilizer, a net profit was obtained of $16.13 per acre. The increase in yield of corn from this treatment was 15.6 bushels, and is larger than any from any other combination consisting of two constituents of plant food, and also from the normal (NPK) application.

(7) Using all three plant-food constituents combined in a complete acid used in the mixture, the increase in yield is barely larger than with the use of potash alone.

(6) By the use of a combination of phosphoric acid and potash, leaving out nitrogen, the average yields and profits were not as great as with phosphoric acid alone.

(7) Using all three plant-food constituents combined in a complete fertilizer, an increase in yield was secured sufficient to give a net profit of $12.25 per acre. This is not as large as when phosphoric acid was used alone or with the combinations of nitrogen and phosphoric acid.

(8) The results show that the use of lime alone has given increased yields and profits; and in combination with a complete fertilizer, larger yields and net profits have been secured than with a complete fertilizer without lime.

(9) From a study of all the results secured, it is evident, first, that phosphoric acid is the controlling plant-food constituent for increasing yields and profits in growing corn; second, that unless more phosphoric

acid is applied the use of nitrogen and potash will be made at a loss; and, third, that lime can be used with profit with the rotation used in this experiment and with a complete fertilizer.

(10) The amount of nitrogen in the normal fertilizer mixture (400 pounds per acre) was 3 per cent, or 12 pounds per acre. This amount was varied so as to give 6, 24 and 36 pounds to the acre with the normal amounts of phosphoric acid and potash. The value of the increase with 6 pounds of nitrogen was $14.15. This is $1.95 more than that from the use of 12 pounds of nitrogen; and lacks only 63 cents of being as much as that from 24 pounds of nitrogen; and 60 cents of being as much as from 36 pounds of nitrogen. Although the increase in yield of corn is some greater from the use of the heavier applications of nitrogen it is not enough to much more than pay for the increase in the cost of the heavier applications. From the results, it is probable that 6 pounds of nitrogen is enough to use on this type of soil, until after other limiting factors of crop production are met.

(11) The amount of phosphoric acid in the normal fertilizer (400 pounds per acre) was 7 per cent, which is equivalent to 28 pounds per acre. This quantity was varied to include 14, 56 and 84 pounds of phosphoric acid per acre with normal quantities of nitrogen and potash. The largest increase in yield was secured from an application of 84 pounds of phosphoric acid, but the largest net returns were secured from the use of 56 pounds of phosphoric acid. The results have shown that phosphoric acid alone gave a greater increase in yield and net profits than from any of the above treatments. This indicates that either 28 pounds of phosphoric acid is enough to use for corn growing, or there are some other factors not satisfied when the phosphoric acid application is increased.

(12) The amount of potash in the normal fertilizer (400 pounds per acre) was 1½ per cent, or 6 pounds per acre. This amount was varied so as to include 3, 12, and 18 pounds of potash per acre. With the exception of 12 pounds of potash, which gave one bushel more increase than did 3 pounds of potash, the plat which received normal amounts of nitrogen and phosphoric acid and ½ normal, or 3 pounds of potash, gave the highest average increase and the largest net returns. From a study of the chemical analysis of this type of soil and these results, it is probable that 3 pounds of potash are enough to use in the production of corn until other factors are changed.

(13) Varying the amounts of the normal fertilizer application (400 pounds per acre) from 200 to 600, 800 and 1,000 pounds per acre gave increased yields for each of the applications, except where 400 pounds were used to the acre. The most profitable application was at the rate of 800 pounds per acre of the normal mixture. After deducting the

cost of fertilizer the different quantities of fertilizer per acre showed the following profits:

200 pounds of fertilizer per acre gave a net profit of	$ 6.49
400 pounds of fertilizer per acre gave a net profit of	6.18
600 pounds of fertilizer per acre gave a net profit of	8.56
800 pounds of fertilizer per acre gave a net profit of	16.17
1,000 pounds of fertilizer per acre gave a net profit of	15.53

Putting this in a slightly different way, the use of 200 pounds of fertilizer yielded a net profit of $3.25 for each 100 pounds of fertilizer used; an application of 400 pounds of fertilizer made a profit of $1.55 per 100 pounds; while 600 pounds made $1.43 profit per 100 pounds; 800 pounds of fertilizer yielded $2.02 per 100 pounds, and 1,000 pounds yielded $1.55 profit per 100 pounds of fertilizer used.

(14) From the chemical analysis of the various upland soils in the western part of the State, the indications are that the results herein reported will apply very well to most of them.

(15) In the production of corn on average upland soils of the character of this, taking all the results herein reported as a whole, it is recommended for well prepared seed beds that something like 400 to 600 pounds of a fertilizer mixture analyzing 10 per cent phosphoric acid, 2 per cent nitrogen and 1 per cent potash, be applied. When soils of this character are built up the nitrogen in the mixture may be reduced or be entirely eliminated. This condition of the soil should be strived for by the growth and plowing into the soil of leguminous crops and crop residues.

EFFECT OF FERTILIZATION UPON OPENING OF COTTON

Since the coming of the cotton boll weevil early fruiting and opening of cotton became of great importance. It is of interest in this connection to know that at the Iredell Farm during the past season those plats which received heavy applications of lime and high percentages of acid phosphate in a complete fertilizer, applied at planting time on a clover sod, were the ones on which the cotton shed its fruit least and opened its cotton early.

COMING OF THE COTTON BOLL WEEVIL

In all probability, cotton growing will always occupy an important position in our agriculture in this State, provided our people adjust their methods of growing this crop to reduce the damage from this pest to the minimum. Below are given some of the precautions that will have to be observed in most effectively meeting this pest of the cotton grower. They are as follows:

1. Be calm under the attack and do not become stampeded. Meet his attack with courage and without being frightened if you wish to win out.

2. The most effective means of combating the boll weevil is by the use of generally good methods of farming.

3. Plant cotton only on uplands. One will run a big risk to plant bottomlands or lands near wooded areas.

4. Use at least 600 pounds of fertilizer to the acre, containing a larger proportion of phosphoric acid than is ordinarily used, avoiding the use of fertilizers too rich in nitrogen, especially on soils rich in this constituent. Apply all the fertilizer before planting the cotton and keep the plants growing vigorously from the start without promoting too rank a growth of plants.

5. Early breaking of the land for cotton in the fall or winter with a two-horse plow, and planting as early in the spring as the ground is warm enough to germinate the seed. Cultivate well and frequently after the crop is up to keep them growing vigorously from the start.

6. Keep fields free from rubbish, grass, weeds and bushes. This means smaller acreage to cotton than has generally been cultivated in the past on the farms of the State.

7. With early spring infestation, pick and destroy all squares that have been punctured. These will usually be at the end of rows near woods, hedgerows, stumps, or fodder stacks. In planting use plenty of well-matured seed.

8. Secure and maintain a moderately thick stand of the plants in the rows not exceeding 8 to 12 inches between plants. This will tend to cause the plants to make smaller growth and to make the cotton mature quicker. Give the cotton plenty of space between the rows (about 4 feet), so that the sunshine can get in to dry up the infested bolls and open the early sound ones.

9. Grow plenty of food and feed crops to meet the needs of the farm to make it as self-sustaining as possible.

10. Avoid excessive rank growth of cotton, as this gives a place for the weevil to hide from the heat and get plenty of food for their growth and multiplication.

11. Use for planting purposes, early fruiting and early opening varieties of cotton, like Cleveland Big Boll, Mexican Big Boll, Express and Edgecombe-Cook.

12. Field select seed of cotton each year from plants that set and open the largest amount of bolls under boll weevil conditions.

13. Grow more summer and winter-growing legumes like soybeans, clovers, and vetches, and use part of them, as far as is practicable to do so, to improve the producing power of the soil, as this is one of the most effective means found of making cotton with or without the boll weevil.

14. After the cotton is gathered, by immediately destroying the cotton stalks, and weeds, chopping up the stalks and other material, and plowing them in five or six inches deep in the fall before frost, and putting the land into suitable cover crops. This will destroy the winter homes and food plants of the weevil and other injurious insects.

15. Plant cotton only on well drained and fairly fertile soils, remembering that those things should be avoided that will tend to promote too rank and late growth of cotton stalks. If the land is too wet at certain times of the year, be sure to plant on ridges. This will tend to make them grow off earlier and mature quicker.

16. Reduce the acreage of cotton to the plow so as to be able to prepare the land early and thoroughly. Get the crop planted early and cultivate thoroughly at frequent intervals.

17. As far as possible locate the cotton fields in the open, far away from the woods or other places where the weevil may be harboring during the winter.

18. Establish on every farm a good crop rotation best suited to the particular conditions on and needs of the farm in which suitable leguminous crops grown with the main money crop are utilized after growth in such a way as far as practicable to do so, so that they will aid in building up the producing power of the soil. This cannot ordinarily be done unless it is planned in advance that a certain portion of the legumes shall go back into the soil for soil-improving purposes.

RESULTS OF WORK IN PLANT BREEDING

At Central Farm.—The field work of the cotton studies under Adams' Project No. 14 has been discontinued and the time previously given to project work has been used in preparing the results of the past eight years for publication, and in a laboratory study of fibers from the different strains. In the study of fibers, width of fiber, tensile strength and number of twists per inch, have been given special attention. The different strains isolated from King cotton have shown considerable variation in width of fiber and number of twists per inch. In correlation tables, where width of fiber and tensile strength are compared, there is a positive correlation between broad fiber and high tensile strength. In the comparison of width of fiber and twist, the largest number of twists per inch are associated with the narrowest fibers.

The study of cotton fibers from different varieties and from the same variety grown in different parts of the State, was suggested by requests from cotton manufacturers and cotton brokers, that we recommend a certain variety of cotton because of its excellent body and spinning qualities. The variety in question was not a high yielder, so microscopic examinations were made to determine the qualities of its fibers which might account for its good body and spinning qualities. When compared with fibers from King, Cleveland and Cook, the variety recommended by the mills had greater breadth of fiber and fewer number of twists per inch. It also had greater strength than the above varieties. When compared with our selected strain of Mexican Big Boll, however, the width of fiber was the same and the breaking strength of Mexican was greater. These studies are being continued to determine further microscopic qualities that may be associated with body and good spinning qualities.

The cotton "Place Effect" study under Adams' Project No. 15 in cooperation with the Mississippi Experiment Station was continued but no comparison was made this season on account of the failure to save seed last year. The strain was grown in Mississippi and in North Carolina this year so that seed will be available for the comparison next year.

SPACING AND SEEDING TESTS

The cotton spacing tests have been continued on the Central and Edgecombe farms. In these tests, one plat has been left unthinned and four others were thinned to 8, 12, 18 and 24 inches between plants in the row. In both of the tests thus far the thickest spacing has produced the highest yield of seed cotton and lint per acre.

At the Iredell Farm further studies have been made of the different rates and dates of seeding wheat and oats. The seedings of October 15 have continued to give best results in this locality. The results of this and the past five years indicate a period between October 10 and 25 to be the best time for seeding small grain in this locality. The date of seedings have been made every fifteen days, beginning with September 1 and extending through to and including December 15. The seedings made September 1 and 15 have been severely damaged by rust and have been less resistant to cold than the October 15 seedings. During the past three years the seedings made December 15 have withstood the cold, but have yielded four bushels per acre less than the seedings of October 15. The seedings were made at the rate of 30, 60, 90 and 120 pounds per acre. When seeded October 15, a 60-pound seeding gave the best results for oats and the 90-pound seeding for wheat. As the time of seeding was delayed, the heavier seedings gave slightly heavier yields. This was particularily true during severe winters.

SEED IMPROVEMENT WORK WITH DIFFERENT CROPS

Corn.—Seed patches from select corn are being grown at the Central, Buncombe, Iredell, Granville, Edgecombe and Washington farms. Each of these farms are stocked with the best strain of corn for their respective sections of the State in which they are located. These corns have yielded from 5 to 7.5 bushels more than the unselected strains generally grown in the State.

Cotton.—High yielding strains of cotton are being selected on the Edgecombe, Pender and Iredell farms. The Mexican Big Boll strain, No. 18, at the Edgecombe Farm, and No. 6 at the Central Farm, have given good results in all sections of the State. These strains furnish $1\frac{1}{16}$-inch staple and are by far the best cottons of their class grown in the State. They have only been exceeded in yield of lint by Cleveland Big Boll, a shorter staple cotton. The Pender Farm has been stocked with a good strain of Cleveland Big Boll. The early strain of King 29 is being selected each year for the upper Piedmont section.

Soybeans.—The soybean selection work is conducted at the Central Farm. This has consisted of pure line selection from the Mammoth Yellow, Haberlandt and Virginia varieties. The Mammoth Yellow beans have been selected for high yield of seed and increased oil content and the others for greater yields of seed. Mammoth Yellow strain, No. 101, has averaged 4.1 bushels per acre more than the general crop seed

of this variety. Strain No. 38 from Haberlandt has averaged 6.3 bushels more than the general crop seed of this variety. Selection No. 12 from the Virginia variety has averaged 2.1 bushels per acre more than the original variety. The soybean work at the Buncombe Farm has attracted particular attention from farmers. At this farm the Haberlandt has stood out as of superior value for both soil improvement and for feed. Through the work of the Extension Service these strains have been distributed and are this year being grown by private growers.

Wheat.—The strain of Leap's Prolific (Nos. 12 and 32) have been further increased. In the variety tests this season, these two strains were outyielded by Purple Straw, an early strain of wheat which is being selected at the Granville Farm. The past season was very favorable to rust infection and the late varieties were more severely damaged by rust. One hundred and fifty bushels of strain No. 12 have been sold this year to growers who are prepared to grow it for seed purposes. Reports from seed sold last season have been very favorable to this strain in spite of the poor season. Strain No. 32, grown at the Iredell Farm, could not be offered for sale on account of the mixture with oats. The best seed have been returned for planting.

Rye.—Strain No. 4 of Abruzzi rye, selected at the Central Farm, has been further increased and was again compared with the best available commercial seed. In the comparison on the Station Farm, our strain No. 4 yielded 5.8 bushels per acre more than the best commercial strain in the test. It yielded 9.4 bushels per acre more than Rosin rye. From the increase plats of this strain 65 bushels have been sold to growers who stated they were prepared to grow it for seed purposes. The Abruzzi rye is earlier in the spring and more upright in habit of growth than the common rye, which fits in better for grazing purposes than the common rye.

Seed House.—The recently constructed seed house at the Central Farm is very well adapted for the care and storage of seed. The building is 20 x 20 feet with a ten-foot pitch and is constructed from a double, fabricated steel garage. Solid ends were used instead of the large double doors and regular windows, and service doors were placed at convenient points on the sides. The building has a cement floor and cement walls extending two feet above the floor. A close joint is made between the steel sides and the cement to prevent the entrance of mice or insects. Ventilation is supplied by 3-inch terra cotta pipes in the floor, a small window on each side, and a regulated ventilator at the top. During the past summer the small grain stored in it has been successfully protected from insects by the use of heat. One heating during the summer proved sufficient protection against the angoumois moth and grain weevil (Colondra granoria) which were present in considerable number just before the treatment.

Rust Resistance in Wheat.—In coöperation with the Division of Plant Pathology, wheat plantings have been made to study the relative yield

and rust resistance of the western wheats in comparison with our local varieties. These comparisons have been made on the Central Farm during the past two years. The western wheats have included Kanred, Beardless, Winter Fife, Malskoff, Michigan Amber, Barletta and a few special selections denoted by number. The local strains with which they were compared are Leap's Prolific, Purple Straw, Stoner, Fulcaster, Fultz, and Alabama Blue Stem and Pool. While Kanred, the leading one of the western wheats, has shown considerably more resistance to rust, it has not yielded so well as the best of our local varieties. Among the local varieties, the earlier strains of Purple Straw have yielded best under heavy rust infection. It was thought that possibly the transfer of seed from Kansas would influence the standing of Kanred, so the past season's comparisons were made with seed grown here the previous year. Home-grown seed of the Kanred made a relatively better standing, but even under these conditions its yield was almost doubled by the early strain of Purple Straw.

PUBLICATIONS

The following publications have been prepared and published during the year, embodying the results and observations of field work by the Division of Agronomy:

Bulletins—

I—Fertilizers for Crops Commonly Grown in North Carolina.

II—Results of Phospho-Germ Experiments Conducted During 1919-1920 (State Department Bulletin, May, 1921).

Results of Fertilizer Experiments with Corn at the Buncombe Farm, for 1911-1917 (In press).

In closing I wish to commend individually the workers of the Division. They have each rendered conscientious and faithful service to the station and to the State.

Respectfully submitted,

C. B. WILLIAMS,

Chief, Division of Agronomy.

REPORT OF THE DIVISION OF ANIMAL INDUSTRY

To the Director:—It is not the intention in the following report to set forth in every detail the work performed by the various workers of the Animal Industry Division, but rather to indicate clearly and concisely a statement of the various phases of work now under way or completed during the last fiscal year.

Some few problems of lesser importance have been dropped due to the stringency of funds. Wherever possible, however, all problems of a short-time nature were concluded. This was done in an effort to help out in the readjustment taking place. The chief efforts of the Division from this standpoint were to continue all experimental problems of a distinctly research nature and all extension problems which could not be dropped or curtailed without seriously interfering with the work.

If it is your desire to have further details concerning any of the experimental or extension problems, such will be gladly furnished upon request.

The following is a summarized report of the Experiment Station offices in the Animal Industry Division:

OFFICE OF BEEF CATTLE AND SHEEP

R. S. Curtis, *In Charge*
Assisted by F. T. Peden *and* George Evans

1. Cotton Seed Meal Studies.

The rapidly increasing use of cotton seed meal in Southern livestock work is making necessary the accumulation of much additional knowledge concerning the use of cotton seed meal as a feed for farm animals.

This work is being conducted with about 25 cows and heifers and 15 calves. The chief discovery during the past year is that females fed on a heavy ration of cotton seed meal usually abort, and where young calves from other cows are fed on the milk from such animals the transmission of the toxicity through this source of feed is clearly evident after a few weeks. This is noted in the emaciated condition of the calves and their generally unthrifty condition, whereas similar calves fed on normal milk grow off without interruption.

This work is coöperative between the Dairy Experimental Office and the Office of Beef Cattle and Sheep. Such a noted scientist as Dr. E. V. McCollum of Johns Hopkins University, Baltimore, Md., after going over this work here last August, pronounces it an important and well conducted line of work of very wide interest, not only from the animal standpoint, but from the standpoint of the consumption of milk by humans.

2. Milk Sickness or Trembles.

This problem has passed the stage of an animal industry feeding problem, it having been well established in the laboratory and in the field of this State that white snake root is the cause of the existing trouble which occurs chiefly in the mountains.

The results of this work have recently been confirmed by Dr. Walter G. Sackett of the University of Chicago, his work substantiating our statements of the presence of a toxic principle in white snake root. This problem thus passes to the stage of isolating the toxic substance. A complete report of the work performed at this station is reported in Technical Bulletin No. 15.

3. Bone and Muscle Building Requirements in Southern Cattle.

This study was inaugurated during the last year with a herd of purebred Hereford cattle, donated by J. E. Latham of Greensboro, N. C. The purpose of this work is to study the bone and muscle building requirements of cattle. Kinds of feed and character of soils on which grown enter into this study to determine whether feed or soil deficiencies of the South are different from other sections of the country.

In addition to the customary means of measuring growth by weight an absolute system of measurements are being used to determine not only the size of the bone, but the various measurements of various parts of the body.

4. Cost of Producing Feeder Cattle.

This work is being conducted on the farm of T. L. Gwyn, in Haywood County, with F. T. Peden, an employee of the Division, in charge of the details of the work.

The problems involved are as follows:

(a) Original cost of calves.
(b) Cost of wintering as calves, yearlings and two-year-olds.
(c) Cost of pasture during same period.
(d) Cost of wintering on various feeds.
(e) Cost of wintering on winter pasture.

The winter pasture phase of this work is one of the interesting points brought out, that is, that cattle can be wintered on orchard grass grazed from the pasture at about one-half the cost when similar cattle are wintered in barns.

The results of the first three years work on this farm were covered in bulletins published simultaneously by the United States Department at Washington, D. C., with whom we were coöperating, and the North Carolina Experiment Station.

The results of the second three years work have been published in United States Department Bulletin No. 954, and the edition from this State is just now ready to come from the press. We are just now entering into the third three years work. The results of these experiments have been widely applied throughout Western North Carolina.

5. The Effect of Cotton Seed Meal on the Health and Reproduction of Breeding Sheep.

This experiment has been completed with the conclusion that cotton seed meal is a safe feed for breeding ewes when fed at the rate of not over one pound of cotton seed meal per 100 pounds live weight.

The use of this feed is growing greatly in favor, especially when the product is fed in the form of crushed cake, either in conjunction with corn silage or pasture.

Results are being compiled for publication.

6. Cost of Producing Early Lambs for Market.

This work is being conducted at the Statesville Test Farm with 35 breeding ewes. The results of this work have shown clearly that lambs can be dropped in December and January, and put on the market during March and April, commanding at this time a premium because of their early availability.

The lambs from this farm last year were sold at 17½ cents per pound gross weight, while lambs of similar breeding dropped on the Central Test Farm, at Raleigh, about one month earlier, were sold at 20 cents per pound live weight.

ANIMAL NUTRITION WORK

J. O. HALVERSON, *In Charge*

1. Studies on Soft Pork.

Experiments in coöperation with Mr. Earl Hostetler, in charge of swine investigations, are being conducted to determine the efficiency of peanuts and peanut by-products on the carcass of hogs.

This work will be continued on a much larger scale when pens for individual feeding are constructed, as the problem has reached the stage where individual feeding has become a necessity.

Data has been worked up in a "Critical Review of the Present Status of Soft Pork Investigations." This is ready for publication in the near future.

2. Mineral Supplements, Chiefly Calciums for Southern Conditions.

Data has been accumulated to show indirectly the pronounced influence of calcium in the ration and its relation to the extent and economy of gain in animals.

This work will be continued, as it is an unusually important problem.

3. Nutritive Value of the Peanut.

This study, supplementary to that of "Soft Pork," has been actively prosecuted with young growing albino rats.

Preliminary experiments have shown the necessity of repeating previously published work, using longer feeding periods in order to ascertain the effect on growth, reproduction and lactation, as well as the effect of the ration on rearing the young from such mothers from weaning age to maturity.

A chemical analysis indicates that the peanut is of high feeding value, especially in protein and oil. Experiments show, however, that there are definite deficiencies.

When this work is concluded supplements to the peanut with substances directly related to farm animals, such as peanut and soybean hay and alfalfa meal, will be given to determine the adequacy and amount necessary. One such preliminary experiment with alfalfa meal has been conducted.

4. The Toxicity of White Snake Root.

The general conclusions on the *poisonous nature of white snake root causing trembles or milk sickness*, published in Technical Bulletin No. 15, of the North Carolina Experiment Station, has recently been confirmed by Dr. Walter G. Sackett, in work done at the University of Chicago.

This work substantiated the presence of a toxic principle in the white snake root. It appears that further animal feeding experiments to establish this toxicity are unnecessary.

The problem is thus open for the isolation of a toxic glucoside, or principle.

5. Onion Flavor in Milk.

This work is being conducted in coöperation with Mr. Stanley Combs, in charge of dairy investigations. Mr. Combs is actively engaged in working out a process for removing the onion flavor from the milk while Dr. Halverson is working on a similar plan to remove the flavor from butter.

Definite results have been obtained by treating onion-flavored butter with a washing process. Laboratory workers could not detect any difference from that of good rendered butter.

The process devised is comparatively inexpensive, and it appears that such expensive fats, if of sufficient quantity, can be recovered and made palatable. Much more work needs to be done, however, to establish definite methods.

POULTRY INVESTIGATIONS AND PATHOLOGY

B. F. KAUPP, *In Charge*
Assisted by J. E. IVEY, M. V. LOUDER *and* E. G. WARDIN

The investigational phases of this office are along three main lines of endeavor:

(a) Disease investigations.
(b) Nutritional investigations.
(c) Breeding studies.

1. Studies in Diseases of Fowls.

A brief resume will be given below of the various specific studies made:

(a) Apparent Oviductitis of a Hen. Mr. Wernle of Chicago has been coöperating in this work and has given some very interesting data on his experience with this disease since last report.

(b) Entero-Hepatitis of Turkeys. It is quite probable that this disease is less prevalent in the mountains than elsewhere. Tests showed that poults taken from flocks where blackhead did not exist, and these poults placed with hens that had been with turkeys infected with blackhead at some time in their lives would begin to die as soon as said poults were about five weeks old.

(c) A Bacteriological Study of the Abscess of the Feet of Single-comb White Leghorns. This trouble is more prevalent with Leghorns than with the larger breeds. The disease is probably due to a weakened condition and lack of resistance to the bacteria when tissues are injured.

(d) Paralysis of the Fowl. Paralysis of the domestic fowl is due to a degeneration of the motor nerve ganglia. When paralysis once occurs in a flock it again reoccurs among the young birds each year after that time. The disease may be combated by substituting a new flock on clean ground.

(e) Volvulus of the Free Portion of the Small Intestines of a Hen. A case of this has been observed in a Single-comb Rhode Island Red hen.

(f) Myxo-Sarcoma of a Barred Plymouth Rock Hen. The tumors involved the liver, pericardium and other of the visceral organs.

(g) Lympho-Sarcoma of a Single-comb White Leghorn Hen. This condition was studied and will be reported later.

(h) Cysto-Lipo-Chondro-Osteo-Adeno-Carci-momata. This compound tumor was studied in a Golden Wyandotte cock. Some areas showed fatty tissue, others bone surrounded with hyaline cartilage, and still other areas showed gland tissue.

(i) Physiology of Respiration of the Domestic Fowl. Studies were made of respiration in the fowl, goose, duck, and turkey, and the average length of breath recorded.

(j) Physiology of Blood Pressure. Blood pressure was taken from the femoral artery connecting directly the femoral artery with the manometer. Average blood pressure of all tests was 115 mm.

(k) Physiology of the Pulse of Fowls. In fowls inspiration raises blood pressure. From the preliminary tests made it appears that the pulse of a chicken is about 300 times per minute.

2. Breeding Work—Inheritance Studies.

The study of inheritance of egg production has progressed satisfactorily. However, some difficulty has been encountered in getting a common flock from which to develop and prove common males and common females with which to proceed to study the powers of transmission of egg-laying qualities by the female.

3. Studies in Feeding Problems.

(a) Amount of Feed Per Hen Per Year. The amount of mash consumed increases as the hen comes into laying and the quantity used depends directly upon the number of eggs layed. Experiments showed that it requires 7.2 pounds of feed to produce one dozen eggs.

(b) Fattening Chickens. The cost per pound increase for feed alone was shown to be 8 cents for the minimum and 23 cents per pound for the maximum.

(c) Cramming Fattening. In 15 birds there was a gain of 28.3 per cent. In another lot of 12 birds there was a gain of 29 per cent, in which case the cost per pound gain for feed alone was 15 cents.

(d) Velvet Bean Meal Tests. Tests were conducted with ground velvet beans, and where 22½ per cent of velvet beans were fed in the ration it produced a deleterious effect upon the health of birds and their performance.

(e) Peanut Meal Tests. Where a 20 per cent peanut meal ration was used in combination with other grains there was a gain of 22 per cent at a cost per pound gain for feed consumed of 14 cents.

4. Egg Production Problems and Studies.

(a) Artificial Illumination. Where artificial illumination was used the hens averaged 42.2 more eggs per year than in the control lots. The hens under lights averaged 28 per cent greater production for the year and produced a dozen eggs for 7.1 pounds of feed consumed, while the controls produced one dozen eggs for 9.6 pounds of feed consumed.

(b) Effects of Straw Lofts on Egg Production. Experiments showed that egg production was not affected.

(c) The Value of Animal and Vegetable Proteins. The vegetable feeds did not replace the animal feeds and did not bring the pullets into early heavy egg production. The conclusion is that animal foods are necessary.

(d) Growth of Single-comb White Leghorn Pullets. A curve has been plotted with which to make comparisons in growth in the use of other feeds.

(e) Growth of Single-comb Rhode Island Reds. A curve is now available for use in comparison with other feeding tests with this breed.

(f) Studies of Factors Influencing the Hatchability of Eggs. The experiment showed that there is a difference of 20 per cent in hatchability in favor of turning eggs five times a day versus eggs turned once each day.

(g) Influence of Moisture Content. In one series where the eggs were sprayed there was 64.5 per cent of the fertile eggs hatched, while in the other series not sprayed there was 54.3 per cent of the fertile eggs hatched.

(h) Dry Lot versus Range. This test was conducted with Single-comb Rhode Island Reds, equally divided on a basis of physical signs and development. The flock on range layed 71 eggs per hen per year, and the flock on dry lot layed 33 eggs per hen per year. The test was conducted for three consecutive years.

(i) The second three years work consisted in studies of the most simple means of compensation. Green feed and meat scrap were given in the mash, but even under this condition the profit for the range flock was $1.08 per hen, and for the dry lot 56 cents per hen. The average for the egg production was 69.9 eggs in the former and 61.1 eggs in the latter per hen per year.

5. Growth Studies and Health.

(a) Velvet Bean Meal Tests. This single test indicated that ground beans, even in only 14 per cent is injurious to the health of the chicks.

(b) Value of Different Animal Proteins. The following is a tabulation of the value of different animal proteins:

Kind of Protein	*Wt. 7 Weeks*	*Wt. 8 Wks.*	*Number Tests*
D. Tankage	0.50	0.64	3
Blood Meal	0.56	0.69	3
Soybean Meal and Dried Milk	0.70	0.82	3
D. Tankage and Peanut Meal	0.54	0.60	1
Meat Scrap	0.59	0.70	2

6. Physics of Incubation.

The indications are that the present hygrometers on the markets, of which we have knowledge, are inaccurate for incubator work.

7. Experimental Extension Project.

In coöperation with the county agent of Polk County, this office conducted a three-years test in the methods that would be most acceptable to educate people past school age, and which are now following farm work.

The final conclusions are:

(a) Personal contact in actual teaching in poultry schools is advisable.

(b) Circular letters and bulletins are not used to advantage.

(c) They do not readily adopt the study-club method.

8. Miscellaneous Work.

(a) During the year 1,680 letters were written on incubation, brooding, feeding, disease, poultry-house construction and marketing.

(b) Dr. Kaupp is secretary of the State Poultry Association and has been active in this capacity. The Sixth Annual Official State Poultry

Show was held at Salisbury in December, 1920, in connection with the North Carolina Livestock and Poultry Associations meeting.

(c) Culling Demonstrations. A culling school was held at the State College for county demonstration agents. A one-day culling school was also held at Salisbury during the poultry show. Between 75 and 100 people attended the school.

(d) Articles for Papers. During the year 32 articles were prepared from this office and used in papers of different types, such as farm papers, and others of a purely technical nature, as for example, The Journal of the American Association of Instructors and Investigators in Poultry Husbandry.

(e) During the year there was a large number of persons interested in poultry personally conducted over the poultry plant. Several scientific workers made visits to go over the work being done.

(f) Special poultry students gave demonstrations in culling, lectures on selection of birds for mating, and judged at several of the county and community fairs during the past year.

(g) A large number of premiums were won at fairs by Experiment Station poultry. Three silver cups, one medal, and a diploma were won at the 1920 State Fair; at the Official State Poultry Show held in Salisbury 30 first premiums were won, 22 seconds, 8 thirds, 4 fourths, 1 fifth, 2 cups, 1 A.P.A. medal and 5 diplomas; two firsts and one A.P.A. diploma were won at the Madison Square Garden Show, New York City.

(h) Several donations in poultry were given for worthy causes during the year.

SWINE EXPERIMENTAL WORK

EARL H. HOSTETLER, *In Charge*

1. Purebred Herd Work—Duroc-Jerseys.

This herd is maintained for demonstrations and exhibition purposes and also for the purpose of raising good uniform pigs for the experimental work. It is very essential to have pigs of uniform breeding, and free from disease and worms, to do accurate experimental work.

2. Effect of Feeding Salt to Swine.

This experiment was conducted to determine whether pigs of different sizes will consume enough feed from a self-feeder to prove fatal after the salt has been withheld for a definite period.

Seven pigs were used—two of them to receive salt from a self-feeder and the others to receive a definite amount of salt in the ration. No deaths have resulted to date.

3. Percentage of Bone in the Carcass of Swine.

This experiment was conducted to determine the amount of bone in the carcass of a hog. Two dressed carcasses were used, the meat all removed and the bones were then boiled.

The results are as follows:

Hog No. 1—Weight, 226 lbs. Bone, 17.7 lbs.

Hog No. 2—Weight, 176 lbs. Bone, 15. lbs.

The results show that the carcass of a hog is composed of about 8 per cent bone.

4. Peanuts and Peanut Meal for Swine.

This experiment was to determine the value of peanuts and peanut meal when fed with other feeds to form a more nearly balanced ration.

Two rations were used—one containing a large per cent of peanuts and the other a large per cent of peanut meal, that will be equal in feeding value and contain the same amount of true digestible protein and other constituents.

The results were that the pigs all made good gains and when slaughtered the carcasses were all soft or medium. The feeding period was 131 days, so that the test was thorough.

5. Comparison of Different Feeds Upon the Shrinkage of Meat.

This work was conducted to determine whether various feeds will influence the shrinkage of meat made from hogs fed these different rations.

Feed apparently has some slight effect on shrinkage. Meat made from hogs that have been fed on peanuts shrink slightly less than that made from hogs that have been fed corn and tankage.

6. Curing Meat in Warm Weather.

Two methods were used: (a) Curing in brine in the usual manner. (b) Pumping brine mixture into the meat.

The results were that meat which was brine pumped was edible but had a very poor flavor. The meat which was not pumped spoiled.

7. Cost of Raising Pigs.

This work was to determine the cost of raising pigs until weaning time when they were 70 days old, which is the usual time of weaning pigs in the Experiment Station herd. This work is not completed but results are available on a similar project from some of the test farms.

8. Soybean Pasture for Hogs.

Soybean pasture, when supplemented with a 2 per cent ration of grain, made the most economical gains on hogs at the Edgecombe Test Farm, where a herd of grade Berkshires is maintained to raise pigs for experimental work.

Peanut pasture was also used at this farm to determine the comparative cost of raising hogs on grazing crops and in dry lots. A determination was also made of the effect of different feeds upon the carcass of hogs.

In this latter phase of the work the Bureau of Animal Industry, at Washington, D. C., coöperated with the Experiment Station. Part of the hogs which had been produced under varying conditions were shipped to Washington to make physical and chemical analysis of the carcass. This work is incomplete but progressing satisfactorily.

9. Cost of Raising Pigs on Statesville and Edgecombe Test Farms.

The litters from the herds at both of these farms are used in this work. The average cost of raising pigs until weaning time on the Edgecombe Test Farm is $4.07 per pig, this being an average of five and one-third years work.

At the Statesville Test Farm the cost of raising each Poland-China pig until weaned is $3.97, this work covering a period of five and three-fourths years.

10. Feeding Farm Work Animals.

An experiment was conducted to determine whether cotton seed meal in the ration will effect the health of horses and mules, and whether it will cheapen the cost of the ration.

The results show that the use of cotton seed meal cheapened the ration slightly and the animals apparently were in good health and condition otherwise.

The results of six years work are summarized and ready for publication. This covers the work conducted on the Edgecombe Test Farm. A similar piece of work was conducted at Statesville, where the results were similar. The use of cotton seed meal in the ration cheapened the cost of keeping each work animal $2.93 per year.

The results of seven years work on this farm are ready for publication.

11. Miscellaneous Work.

At the recent State Fair 20 hogs from the Experiment Station Duroc-Jersey herd competed for premiums. A large number of premiums was won, among them the grand championship on a junior yearling boar.

DAIRY EXPERIMENTAL OFFICE

STANLEY COMBS, *In Charge*

The work of the Dairy Experimental Office is confined to the following:

(a) Pender Test Farm, Willard, N. C.
(b) Central Test Farm, Raleigh, N. C.
(c) L. F. Uzzle Herd, Wilsons Mills, N. C.

1. Herd Development Work, Pender Test Farm.

The work on this farm is largely a continuation of the herd development work that has been in progress for some time. The milking herd consists of 22 cows, 21 of which are daughters of Eminent 19th, No. 78,620.

Two herd sires are maintained. Fourteen of the cows are in the register of merit and hold three State records, as follows:

(a) Pender Eminent Lass E, No. 369,040, is the champion junior four-year-old cow in North Carolina, with a record of 10,751.8 pounds of milk, and 563.99 pounds of fat. North Carolina has only three such cows to date, and one of these is an Eminent bred cow and a half sister of Lass E.

(b) Pender Eminent Lass L, No. 369,046, holds the State record for all junior two-year-old cows in North Carolina, with a record of 9,987.7 pounds of milk and 523.24 pounds of fat. All of these records have been completed within the last twelve months.

2. Cotton Seed Meal as a Source of Protein for Maturing Dairy Heifers.

The heifer calves produced in this herd are all retained. They are immediately placed in the feeding experiment to determine whether cotton seed meal is superior in quality to peanut meal as a source of protein for maturing dairy cows. This work is incomplete, as it is necessarily a long-time experiment.

3. Financial Report of the Pender Herd.

This herd is paying its own way, which is very unusual considering the fact that real experimental work is usually conducted at a loss. This speaks well for the way in which the herd has been bred up and handled. A mediocre or average herd subjected to experimental work could not make such a record.

The production of milk for the year ending October 31 amounts to 148,730.7 pounds, and of fat 7,652.4 pounds. A complete report of this herd is available for examination.

4. Velvet Bean Meal Experiment.

This office, in coöperation with the South Carolina and Alabama stations, conducted experiments to determine the comparative feeding value of velvet bean meal and wheat bran, as a protein supplement to cotton seed meal.

Twelve cows were used in the Pender herd to conduct the North Carolina part of this work. The results show that a velvet bean meal ration lacks palatability, and that cows will not readily consume a full ration. When the animals were allowed to graze it was found necessary to change the grain mixture in order that they might consume a full ration.

5. Effect of Cotton Seed Meal Upon the Growth and Reproduction of Cows.

This work is conducted coöperatively by Messrs. Combs and Curtis, inasmuch as it is a problem that concerns both beef and dairy cattle.

A herd of Ayrshires is used for this work and during the last year definite results have been obtained. The following facts are important and are therefore given in some detail.

Lot No. 1 consisted of 8 cows, which were fed a ration of cotton seed meal and cotton seed hulls.

(a) Cow No. 101 dropped twin calves in February, 1921. Both calves were allowed to nurse the dam for six weeks. At this time one calf was found to be totally blind and the eye-sight of the other affected. The latter calf was transferred to a nurse cow receiving a normal ration. The calf grew and retained its sight. At six months of age there was approximately 200 pounds difference in the weight of the two calves, thus furnishing evidence that milk from animals on restricted rations is not normal.

(b) Cow No. 102 aborted twin calves at seven months. Post mortem showed these calves to have blind eyes, congested heart and liver, together with soft bones, indicating a lack of minerals.

(c) Cow No. 103 aborted at eight and one-half months. Calf blind and bones soft. The calves from both No. 102 and No. 103 showed œdema in the joints of the legs.

(d) Cow No. 104 failed to breed. She has developed two typical cases of dropsy during the year and is subject to fits from time to time.

(e) Cow No. 105 aborted at about five and one-half months. Failed to come in milk and was later slaughtered.

(f) Cow No. 106 aborted at about seven and one-half months; calf blind and had developed a cataract in each eye.

(g) Cow No. 107 aborted at eight months. Calf blind. Cow now has developed a cataract in each eye. Other portions of her eye show cloudiness.

(h) Cow No. 108 died after showing a dropsied condition, and had suffered from several fits.

Lot No. 2 consisted of 4 cows, which were fed a ration of cracked corn, corn stover and corn silage.

(a) Cow No. 201 calved a few days before normal time. Calf weak, head drawn upward and backward. Calf lived only a couple of days.

(b) Cow No. 202 suffered for about ten weeks with a dropsied condition, her head and neck being swollen. The neck was swollen and head drawn to the side for several weeks. Oedema of the legs appeared and these swellings broke and matter appeared for several days. Finally, after being off feed for some time, this cow aborted.

(c) Cow No. 203 calved a few days ahead of time. Calf similar to that from No. 201 and lived only a couple of days.

(d) Cow No. 204 carried calf about two weeks over time. Calf weak but was able to stand alone. It never nursed without help and died in about 60 hours.

Lot No. 3 consisted of 4 cows, which were fed a ration of crushed corn, cotton seed meal, cotton seed hulls, corn stover and silage.

(a) Cow No. 301 went off feed early in the year. Remained in weak condition for several months, getting so low that it was thought best to turn her on pasture to prevent death. During this time she jumped from a truck, causing abortion the same day. She was later slaughtered.

(b) Cow No. 302 failed to breed and was slaughtered.

(c) Cow No. 303 aborted at about eight months.

(d) Cow No. 304 aborted.

Lot No. 4 consisted of 4 cows, which were fed a ration of cotton seed meal and corn silage.

(a) Cow No. 401. After the experience with the other three cows of this lot, this cow was placed on normal ration, but not early enough to save the calf.

(b) Cows Nos. 402, 403 and 404. These cows all went off feed early in the gestation period, No. 404 finally dying. The other two were changing so rapidly that it was thought best to place them on normal ration. After regaining health they were again put back on the experimental feed. Both aborted and are in poor condition at the present time.

Lot No. 5 consisted of 4 cows, which were fed a check ration with normal results.

The milk from the cows on these various rations is used for feeding calves. Calves are secured from the herds of local dairymen. There appears to be a considerable difference in the feeding value of the milk from different lots. Some of the calves grow slowly even when given as much as fourteen pounds of this milk daily.

6. Private Herd Work.

A coöperative piece of work has been inaugurated at Wilsons Mills in a large commercial dairy herd. This herd has been operated for several years without any profit and Mr. Combs has taken the matter in hand with the idea of putting the herd on a paying basis. The results at present look encouraging.

7. Onion-flavored Milk.

This office is still working with the "Onion-flavored Milk Problem," with very gratifying results. This odor and flavor is produced by allyl sulphide, a compound of sulphur. This compound may be precipitated with mercuric chloride ($HgCl_2$) or platinum chloride ($PtCl_4$).

Numerous samples of fresh milk were treated with various amounts of allyl sulphide and heated in a water bath to a temperature of 140 to 150 degrees Fahrenheit. While being held at this temperature a current of air was passed through the milk by means of a small foot pump. This treatment proved successful.

This treatment of pumping air through the milk was repeated with natural onion-flavored milk, produced by feeding a cow 1½ pounds of green onion tops one and one-half hours before milking. This treatment is giving encouraging results and if worked out in a commercial way will mean much to the dairy industry of the South.

8. Miscellaneous Work.

Considerable time has been spent in the past year making plans for the enlargement of the dairy experimental work. Plans are now on foot to study the effect of climatic conditions upon the production of milk at the Pender farm.

The idea now is to extend this work by coöperating with the American Jersey Cattle Club, thus making use of a large number of herds throughout the United States. By blocking off the United States according to temperature, rainfall and humidity, much valuable information will be obtained.

PUBLICATIONS

(a) Intussusception of the Posterior Part of the Small Intestines of a Buff Plymouth Rock Chick, by B. F. Kaupp, in *Journal of American Veterinary Medical Association.*

(b) Mineral Content of Southern Poultry Feeds, by B. F. Kaupp, N. C. Department of Agriculture Bulletin.

(c) Observations Regarding Pathological Conditions in Fowls, by B. F. Kaupp, from Poultry Pathological Research Laboratory.

(d) Paralysis of the Domestic Fowl, by B. F. Kaupp, reprint from *Journal of the American Association of Instructors and Investigators in Poultry Husbandry.*

(e) Study of Some Poultry Feed Mixtures With Reference to Their Potential Acidity and Their Potential Alkalinity, by Messrs. Kaupp and Ivey. Reprint from *Journal of Agricultural Research.*

(f) Thirty-two articles were prepared from the Office of Poultry Investigations and Pathology, and printed in various popular and scientific journals.

(g) Revised Points of the Score Card, published as an Extension Circular No. 116, by W. W. Shay.

(h) Monthly Blotter of Timely Suggestions, by W. W. Shay.

(i) Scenario for Moving-picture in process of completion, by W. W. Shay.

(j) Farm Fencing, by W. W. Shay, B. F. Kaupp, George Evans and A. C. Kimrey. Published as Extension Circular No. 118.

(k) Wintering and Feeding Cattle in Western North Carolina, by R. S. Curtis, F. T. Peden, and F. W. Farley, in press.

(l) Cotton Seed Meal and Its Effects on Growth and Reproduction of Cows, by Messrs. Combs and Curtis, in *Journal of Dairy Science.*

(m) Milk for the Family, compiled by Dairy Extension Office and published by Mrs. Jane McKimmon.

(n) Milk, Our Best Food, by Stanley Combs, in editor's hands.

(o) Family Cow Poster, by Stanley Combs, in editor's hands.

(p) Young Folks Judging Contest Circular, by Messrs. Combs and Curtis, in North Carolina Livestock Association Reprints.

(q) Cost of Raising Pigs to Weaning Time, by Dan T. Gray and Earl Hostetler; ready for publication.

(r) Feeding Farm Work Animals, by Earl Hostetler; ready for publication.

(s) Preparation of Pork on the Farm, by Mrs. Cornelia Morris and Earl Hostetler; ready for publication.

(t) Program of the North Carolina State Livestock Meeting, by R. S. Curtis, Chairman.

(u) Score Card for Beef Cattle, by R. S. Curtis, Extension Circular No. 26.

(v) Critical Review of the Present Status of Soft Pork Investigation, by Dr. J. O. Halverson; ready for publication.

(w) Use of Milk in the Diet, by Dr. J. O. Halverson, in preparation.

(x) Use of Fruit and Vegetables in the Diet, by Dr. J. O. Halverson, in preparation.

If you desire further information, I will be pleased to furnish it upon request.

Respectfully submitted,

R. S. CURTIS,
Animal Industry Division.

REPORT OF THE DIVISION OF ENTOMOLOGY

To the Director:—I present the following report on operations under my charge in investigations in entomology for the year 1921.

The entire list of projects has been given in previous reports and outlines of each are on file with you. In some of these no new data has been secured during the year; in a few the insects have not appeared this year in numbers to attract attention. On the other hand circumstances have led us to make some studies on subjects not heretofore formally listed as projects.

R. W. Leiby was absent on leave during much of the year for advanced study at Cornell University and returned to our service in June as Dr. Leiby, having obtained his Ph.D. degree.

INVESTIGATIONS

Pecan Insects (R. W. Leiby).—Little new data. Data of past years is being studied and prepared so that publication will soon be possible. Much of the life-history work has been completed and many photographs made.

Larger Cornstalk Borer (R. W. Leiby).—This project was largely completed with the publication of Department Bulletin 274 (August, 1920). It is intended yet to prepare an extension circular which shall give the most essential findings in condensed form for use of farmers and county agents.

Potato Spraying (R. W. Leiby).—For the eighth year tests have been carried out at the Buncombe Branch Station. This is in continuation of the work which has been reported in Department Bulletin 254 (March, 1919), and Extension Circular 103 (March, 1920). S. C. Clapp, Superintendent at Swannanoa, has given the greatest help in this work.

We present the following table of data secured from the work of 1921:

POTATO SPRAYING AT BUNCOMBE BRANCH STATION IN 1921

Plot	Treatment	Applications	Yield Bus. Per Acre	Value Per Acre	Per Cent Gain in Bus. Per Acre Over Average of Both Checks	Per Cent Gain in Bus. Per Acre Over Check Plot 1
1	None (check)	None	95	$132.05	(Check)	(Check)
2	Hand-sprayed 4-5-1½-50	5	158	$231.05	43.64	66.31
3	Hand-sprayed 3-4-1½-50	5	151	$219.85	37.28	59

POTATO SPRAYING AT BUNCOMBE BRANCH STATION IN 1921—
Continued

Plot	Treatment	Applications	Yield Bus. Per Acre	Value Per Acre	Per Cent Gain in Bus. Per Acre Over Average of Both Checks	Per Cent Gain in Bus. Per Acre Over Check Plot 5
4	Hand-sprayed 3-4-1½-50	4	154	$223.42	40.37	23.20
5	None (check)	None	125	$173.45	(Check)	(Check)
6	Hand-sprayed 1½-50 A. of Lead and water	4	132	$182.81	20	5.60
7	Machine-sprayed 3-4-1½-50	5	140	$199.82	27.27	12

Plots 1 to 3, inclusive, were in *sorghum* the preceding year, while Plots 4 to 7, inclusive, were in *cabbage* the preceding year, which accounts for much of the difference in yields. For this reason we give data for the series as a whole, and also as two separate series.

We find the highest gain in the plots which are hand-sprayed with standard home-made poisoned Bordeaux Mixture. Machine-spraying, while good, is not so thorough, though in this particular work we admit that with additional nozzles the machine would have given better results than it did. Arsenate and water (without the bluestone) may control the potato beetle, but it does not have the stimulating effect of the Bordeaux.

In our calculations primes are figured at $1.50 per bushel and culls at 30 cents per bushel.

Insect Survey (C. S. Brimley, in charge, others aiding).—During the year 474 species of insects, not heretofore known to occur in the State, have been added to our lists, bringing the total number to 6,221 species now on record. Mr. Brimley has given much attention to several groups of highly beneficial parasitic insects and the findings throw light upon the natural control of such pests as army worm, green clover worm, and others. Mr. Mitchell has added greatly to our knowledge of the native bees. Mr. Haber has arranged and installed a new and larger insect exhibit in the Museum. Mr. Sherman has made additions in the group of beetles. We have lately arranged with a specialist to identify all our specimens of nut-weevils which *resemble* the cotton boll weevil, so as to give us not only a better conception of our nut-

weevils, but also enable us to give more explicit information when these are sent to us (as is often the case) under belief that they are boll weevils.

We are making substantial progress in ascertaining the insect life of the State, its seasonal activity, and its geographical distribution.

Cabbage Dusting (R. W. Leiby).—Experiments in the use of dry dust poisons for control of the common cabbage worms have been conducted at the Swannanoa Branch Station for several years. While the results of the most recent tests were not so good as of the earlier experiments, we are convinced that these treatments are effective when given often, and are safe with ordinary precaution. As it is not a new thing to control such insects with poisons, our principal object is to prove efficiency and safety, even perhaps without such detailed data as in the potato-spraying work, where more complicated factors are involved. We look forward to the preparation of an extension circular on this subject. S. C. Clapp, at Swannanoa, has aided greatly in this work.

Cut-worms (C. S. Brimley).—Several of the standard poison-baits have been used to protect plants in gardens and these have given general satisfaction.

The chief effort has been to determine the relative abundance of our several species of cut-worms, and the time of emergence and flight of the adult moths, not only because of the biological information involved, but also as bearing on the cultural methods of control. Bait-traps have been operated, as it has been found that most cut-worm moths are quite freely attracted to baits.

Until this year we had but little data on the species known as *Feltia gladiaria*, Morr,—its larva was common enough as an early spring cut-worm, but the bait-traps yielded no moths. This year Mr. Brimley reared this insect from cut-worm to moth and demonstrated that although the cut-worms become grown in early spring, they do not pupate until September, the moths emerging and laying their eggs in the fall, and the partly-grown cut-worms passing through the winter. The moth of this particular species apparently is *not* much attracted to baits. This work indicates that the time of egg-laying of this species is much the same as with most of our other species.

The bait-traps have always made the heaviest catches of cut-worm moths in September, which indicates that August is a favorable month for cultivating infested lands to destroy the on-coming generation of cut-worm moths.

Cotton Boll Weevil (Office force).—As yet our chief work has been to determine the spread of this insect from year to year, and to give all information possible to farmers and county agents as to the general problem, this latter being "extension" work, is mentioned in report on extension.

The new area invaded by the boll weevil in this State in 1921 is approximately twice as wide as the area invaded in 1920. The accompanying map shows the spread since it invaded the State in 1919. After we had a large part of the 1921 area defined, R. C. Gaines, of the United States Bureau of Entomology, spent a week in the State and determined a series of "northernmost" points across the State from west to east, which enables us to run the line as shown.

The United States Bureau of Entomology maintains a special boll weevil laboratory at Tallulah, La., at which a force of entomologists, chemists and mechanics is employed. The work there and elsewhere has covered the general study of the life, habits, and control of the weevil. It will be for us to work out such departures or minor variations from their findings as may occur in our State, and by extension methods to teach to our people the essential truths which they can profitably use.

Household Insects (V. R. Haber).—During the year treatments, supervision or advice have been given in 56 instances. The pests with which most work has been done are: cockroaches, bed-bugs, fleas, and weevils of various kinds in seeds and grains.

In brief, it is found that with *cockroaches* extreme cleanliness and the dusting of sodium flouride in places where they most frequent is the most effective procedure. With *bed-bugs* the use of gasoline in cracks and crevices, or fumigation of the infested house with hydrocyanic gas. With *fleas,* a misty spray of gasoline, free use of lime where cat and dog sleep, use of insect powder on these animals, or getting rid of them altogether. With various weevils use has been made of carbon disulphide and hydrocyanic acid gas for fumigation.

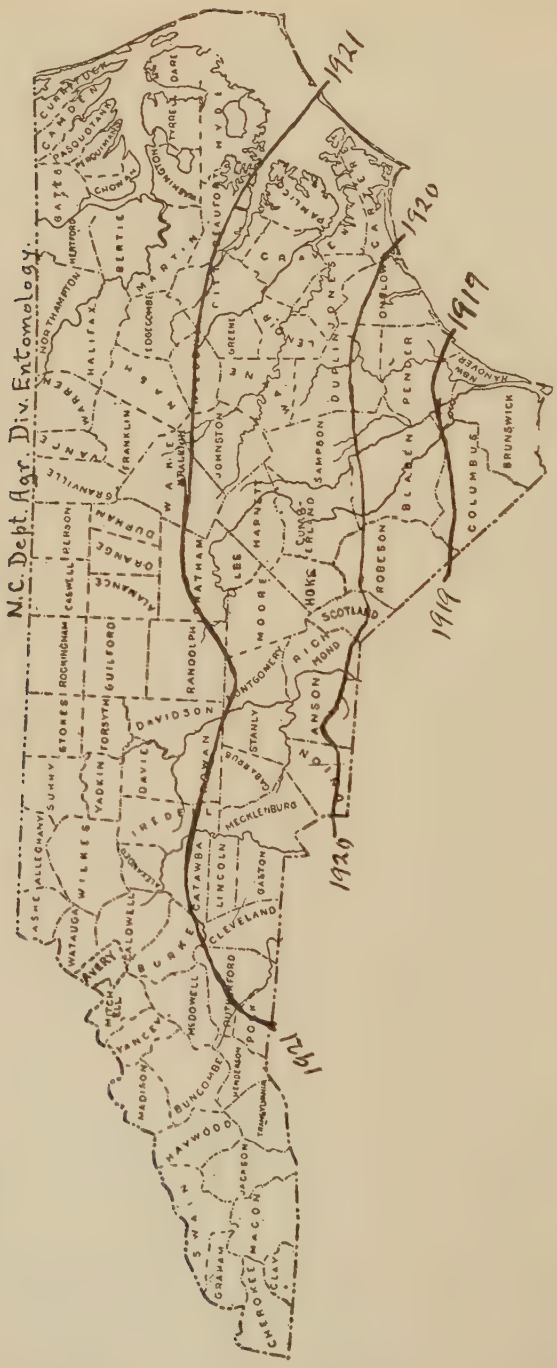
Numerous other expedients are available in special cases, as the use of heat, tight storage, beating, brushing and exposing infected materials to sunlight, use of moth balls and the powders and poisons which are on sale at many stores.

This whole subject of household insects embraces more problems, and of more important nature than is generally appreciated, especially if we include under this head the weevils of grains.

In the great majority of cases the treatments given or advised have given satisfactory results.

NEW PROJECTS UNDER WAY OR IN PROSPECT

Canker-worms.—Beginning in 1917 there have been local outbreaks each year of the fall canker-worm in certain forest areas of our mountain counties. The areas affected vary in extent from a few acres to hundreds or thousands of acres, and the worms eat off the leaves in May and June until the trees are as bare as in winter. The trees then put out a partial and belated foliage in July. In these wild mountain areas such remedies as banding and spraying are not practicable. In 1920 we were able to do our first work on this subject and made a study of the natural enemies, which were in evidence. Certain predaceous ene-



Spread of Cotton Boll Weevil in North Carolina During the Years of 1919, 1920 and 1921.

mies of the worms were present in helpful number, also an egg-parasite which checked their increase. In some of the areas the damage was less in 1920 than before, in others it was still severe. We hope to make further studies.

Control of Peach Borer.—Within the past few years the chemical known as *paradichlorobenzene* (sometimes called "para," "p-c-benzene"), has been found to be useful in control of the peach borer. We did not originate this method, most of the investigation work being done by the United States Bureau of Entomology and the New Jersey Experiment Station. As the method promises well, and as work with it is yet in the experimental stage, it seems desirable to secure some data and experience of our own. Dr. Leiby is, therefore, undertaking some tests with this material.

Peach Curculio.—For several years our commercial peach growers have suffered unusual losses from this insect, and this year (1921) the losses were greater than ever before. The Sandhill Fruit-growers Association has requested aid of both this Division and of the United States Bureau of Entomology, and each is undertaking to furnish a man through a part of the coming season. It is intended to make field and laboratory observations to keep pace with the activities of the insect, and thus give quick word to growers as to exact best time to apply poisons, pick up and destroy "drops," etc.

Parasites of Hessian Fly.—The Hessian Fly is frequently destructive to wheat in this State, yet in many years it is entirely inconspicuous. It is known that parasites play an important part in holding it down in the years when it is not destructive. We wish to find out what species of parasites are most helpful against the fly in this State, to determine which ones are most effective, and to learn something of their life and activities. Accordingly, we are making a start toward securing material for these studies.

PUBLICATIONS

During the year under review the following articles have been published by members of our staff, based on their work in this Division:

Articles in Scientific Journals

Oviposition by an Evaniid, by V. R. Haber, in *Canadian Entomologist*. November, 1920. Notes on egg-laying habits of a parasite which breeds in the eggs of cockroaches. Three pages.

Note on Moulting of Cicadas (July-flies), by V. R. Haber and W. Bruce Mabee, *Entomological News*, April, 1921. One page.

Bee-flies (Bombyliidæ) of North Carolina, by C. S. Brimley, *Entomological News*, June, 1921. Review of the species of this family known to occur in the State. Three pages.

A State Insect Survey Project, by F. Sherman and C. S. Brimley, *Entomological News*, October, 1921. Review of methods of work and progress in the study of the insect life of the State. Four pages.

Press Articles

Spraying Fruit Trees, by W. Bruce Mabee, *Extension Farm News*, January 26, 1921.

Potato Spraying, by R. W. Leiby, *Progressive Farmer*, February, 1921.

Honey-producing Possibilities of North Carolina, by V. R. Haber, with aid of C. L. Sams, *American Bee Journal*, June, 1921.

Spread of Cotton Boll Weevil This Season to Date, by F. Sherman, Raleigh *News and Observer*, September, 1921.

Paradichlorobenzene for Control of Peach Borer, by R. W. Leiby, *Progressive Farmer*, September 24, 1921.

ACKNOWLEDGMENT

It is a pleasure to acknowledge the support granted at all times by the Board of Agriculture, by the Commissioner, and by yourself as Director. Also to commend the several workers in the division whose efforts have made possible whatever of merit has been accomplished.

Respectfully submitted,

FRANKLIN SHERMAN,
Chief in Entomology.

Report of Entomologist

To the Director:—I am transmitting herewith a brief report of the work of the Division of Entomology for the year ending December 31, 1921.

During the past year all lines of work have been more or less handicapped by lack of funds. However, it is a pleasure to be able to report satisfactory progress in most lines in spite of this handicap.

The cowpea weevil project has been confined to a study of the life histories of the common forms, together with a study of its common parasites, which has been very effective in controlling this pest in the field during the past two years. Repeated experiments with air-slacked lime have clearly demonstrated that this is the most satisfactory method for the control of these pests.

The field experiments on corn-root worms had to be abandoned on account of lack of funds, but breeding experiments have been started with this pest and laboratory tests with soil insecticides have been started, and it is believed that another year will show satisfactory results in this direction.

During the past year we have carried on a series of experiments for the control of mill insects in one of the largest mills of the State. It has been possible for us to so simplify mill fumigation as to put it on a practical basis, and thus effect a material saving for the mills of the State.

Experiments with the trap-bed methods for the control of the tobacco flea beetle show that this is one of the easiest and most effective methods

for the control of this insect. Demonstrations were carried on by five farmers in Edgecombe County this past year. Reports by these farmers state that they believe that this method was worth from $20 to $30 per acre to them, because it gave them a more uniform stand and saved a great deal of labor in replanting and harvesting. All the farmers reporting stressed the fact that this remedy would be much more effective if all the farmers in a given locality would use it.

Work on all phases of the leaf hopper project has progressed more rapidly than was expected. The bibliography on these insects will be ready for publication in the spring and the index is about 80 per cent completed. A review of the plant hoppers of eastern North America has been completed, and will be published early in the year. This is the first time that this group of insects has been thoroughly reviewed and placed on a satisfactory basis, so that we can proceed with our studies of the life histories, economics and methods of control.

Respectfully submitted,

Z. P. METCALF,
Entomologist.

REPORT OF THE DIVISION OF HORTICULTURE

To the Director:—I herewith submit the report of the experimental work of the Division of Horticulture for the fiscal year ending June 30, 1921.

The experimental work of the Division is being continued along the lines of the projects described in previous reports.

During the year, considerable attention has been given to a more thorough direction and organization of the work. The organization of investigation so that direct attention to problems of outstanding importance may be developed has been borne in mind. Every attempt is being made to develop a program of work which will contain live projects definitely adapted to fundamental and special problems of the State. The projects are being organized so that problems of first importance will be selected, and so that the expenditure of funds and energy on problems of only local application will be limited. Every project is reviewed each year with a critical attitude to see if it is fulfilling the purpose for which it was intended.

EXPERIMENTAL WORK IN POMOLOGY

1. *Variety Work in Pomology* (C. D. Matthews and J. M. Dyer).

Notes and observations on the behavior of varieties of fruits in the different sections of the State are made from year to year. These notes and observations show the range of adaptability of the varieties in different sections.

Much time and care is expended each year in writing, revising and checking descriptions of almost all of the important varieties of fruit grown in the State. These descriptions are to be used in future publications, and are employed by the Division as an aid in identifying varieties of fruit sent to the office from over the State.

2. *Native Fruits of North Carolina* (C. D. Matthews).

The place of origin, the history, and the description of a number of varieties of North Carolina origin have been secured. When opportunity offered, the descriptions of varieties secured previous to this season were verified. Paintings and photographs have been made of the most important varieties.

3. *Investigational Work With Peaches* (Mountain Station, Truck Station, Piedmont Station, Coastal Plain Station—C. D. Matthews and J. M. Dyer).

(a) *"Dehorning" Peach Trees.*—No active work done on this project during the year.

(b) *Peach Breeding.*—It is the object of this project to produce improved commercial varieties that are more suited to North Carolina

conditions than are the present varieties. It is the purpose to produce varieties hardier in bud than the present commercial sorts.

To provide working material for this project, a variety orchard containing over 60 different varieties of peaches was planted at the Truck Station during 1917. These trees have made a very satisfactory growth since being planted. Late spring frost destroyed the blossoms, making it impossible to do any work this year. There is a good set of fruit buds on the trees, and active work is to be done on this project during the following year.

(c) *Hardiness of Peach Varieties in Western North Carolina.*—Twenty varieties of peaches, comprising varieties adapted both to extreme northern and to southern conditions, were planted at the Mountain Station in the spring of 1919 to furnish material for work on determining the relative hardiness of different peach varieties in Western North Carolina. These trees have made a very satisfactory growth since being planted.

(d) *Phenological Studies With Peaches.*—The practice of collecting phenological notes on the peach varieties in the varietal peach orchard at the Truck Station was started during the spring of 1920. These notes will be of immense value in handling the breeding project.

(e) *Variety Testing With Peaches.*—No active work was done on this project because the crop at the Truck Station was killed by late spring frosts.

4. *Investigational Work With Pecans* (Truck Station, Coastal Plain Station and Piedmont Station—C. D. Matthews and J. M. Dyer).

(a) *Variety Testing.*—Thirty-two of the most important southern varieties are included in this test, which has been conducted for 15 years. Gratifying results are being secured from this work, as certain varieties are showing marked adaptability to North Carolina conditions, while others are proving to be undesirable. At this time, valuable recommendations regarding pecan varieties for planting in this State can be made. According to the results secured, the Schley, Stuart and Alley varieties are the most desirable for Eastern North Carolina.

(b) *Individual Tree Performance Records.*—The securing of performance records of the individual pecan trees in the experimental orchards at the several stations is being continued from year to year. Such a record affords a more detailed study of the behavior of the different varieties. As a result of the individual tree performance records, it has been noted that trees of the same variety under identical conditions are uniformly heavy yielders, while others are very poor producers, that some produce uniformly large nuts and others uniformly small nuts. As these individual performance records suggest the possibility of improving and standardizing individual yields by bud selection, work has been started along this line.

(c) *Cultural Practices.*—The value of correct cultural practices, such as tillage and the use of cover crops, is clearly shown in the increased size of trees, and in the increased size and number of nuts produced when compared to trees and their products grown in sod. To determine the most desirable system of tillage and cover cropping to be employed in pecan orchards, work of this nature is being conducted at the branch stations.

(d) *Pecan Breeding.*—The seedlings, as a result of pecan breeding work, that were set in 1915 at the Truck Station, are making a satisfactory growth. Some of these seedlings are of bearing size and should produce some nuts during the coming year.

(e) *Top-working Pecan Trees.*—The investigations dealing with the methods of budding and grafting employed in top-working pecan trees was continued this year. It has been found that a combination of both grafting and budding should be used to secure the most satisfactory results. As a result of years of investigation, it is the opinion of this Division that top-working should be confined, as a general rule, to trees not over 8 to 10 years old, to be entirely successful.

(f) *Cracking Tests With Pecan Varieties.*—The cracking test of the different varieties is made each year. The cracking test is a necessary adjunct to the performance record of a given variety in determining its value in a certain section. Very often a variety is highly satisfactory from a productive standpoint, but the cracking test shows it to be nearly worthless from a utility viewpoint. The cracking test shows the number of nuts per pound and determines the per cent of unbroken halves the variety will crack out, the per cent of shrunken kernels, the per cent of physiological spot, the per cent of faulty nuts, and shape and size of the kernels, the texture, quality and flavor of meat, the per cent of meat and the thickness of shell. As a result of these cracking tests conducted each year, certain varieties that were satisfactory from a productive standpoint proved to be totally unsuited to North Carolina conditions.

5. *Investigational Work With Strawberries* (Truck Station—C. D. Matthews and L. H. Nelson).

(a) *Variety Testing.*—This project was discontinued temporarily because of lack of funds. The variety testing project with strawberries was initiated several years ago with the purpose of determining whether or not there were any other varieties more desirable as commercial market varieties than Klondike and Missionary, the two leading commercial varieties. For this State the most profitable berry combines the characteristics of productiveness, earliness, and shipping quality. None of the varieties so far tested have shown themselves superior to Klondike and Missionary as commercial varieties. Several of the varieties have shown themselves valuable for home use.

(b) *Cultural Practices.*—During the year experiments to determine the most desirable planting dates were conducted, as well as work to determine the value of removing blossoms and cutting runners. This project has not been in operation a sufficient length of time to furnish any conclusive information.

6. *Investigations With Apples* (Mountain Station, Piedmont Station and Truck Station—C. D. Matthews and J. M. Dyer).

(a) *Pruning* (Mountain Station).—The pruning project was begun during 1919 with the intention of securing information on the desirable height to head apple trees, to determine the comparative value of the open head and the modified leader system of training, and to secure information on the amount of annual pruning most desirable. To supply material for this work an orchard containing approximately 128 trees was planted at the Mountain Station in the spring of 1919. The trees have made a very satisfactory growth and the first and second year's work has been completed as planned.

(b) *Apple Thinning* (Mountain Station and Piedmont Station).—Experiments to determine the effect of thinning fruits and leaves from the fruit spurs of the apple were initiated. Work on this project has not been conducted a sufficient length of time to supply information on the subject.

(c) *Summer Apples* (Truck Station).—The summer apple orchard at the Truck Station did not produce a crop this season because of frost injury.

EXPERIMENTAL WORK IN VEGETABLE CULTURE

1. *Investigational Work With Sweet Potatoes* (Truck Station—C. D. Matthews and L. H. Nelson).

(a) *Variety Testing.*—It is the purpose of this work to determine the most desirable varieties of sweet potatoes for Eastern North Carolina from the standpoint of productivity, market value, keeping quality and quality. There were 29 varieties under observation this year. The results were, in the main, confirmatory of the work of previous seasons. Certain varieties have proven their desirability while others have shown themselves to be undesirable.

(b) *Storage.*—In connection with the variety work, storage tests are being made from year to year in the storage house to determine the behavior of the different varieties in storage. Certain varieties have proven themselves to be better keepers than others.

To facilitate the storage investigational work an additional curing room was constructed during the summer.

Investigations to determine the relation of time of digging to keeping quality, the relation of proper harvesting to keeping quality, the proper method of curing, and the correct management of the house, have been continued this season.

As a result of this work the division can authoritatively make recommendations regarding varieties for storage and the most desirable methods to employ in the managment of the storage house.

(c) *Cultural Practices.*—During the year work was conducted to secure information on the following different cultural practices:

(1) The comparative value of slips vs. vine cuttings as regards productivity.
(2) The effect of ridging on productivity and type of potatoes.
(3) The effect of vine cuttings on yield.

(d) *Seed Selection.*—The following lines of work dealing with the seed selection of sweet potatoes were conducted during the year:

(1) To determine the relative value of seed stock from high-yielding and low-yielding hills as regards productivity and uniformity of potatoes.
(2) To determine the relative value of vine cuttings as compared with slips for maintaining yield and type, commencing from the same hill.
(3) To determine the comparative value of large and small potatoes for seed.
(4) To determine the comparative value of seed from late vine cuttings and seed from main crop draws as regards productivity, type and keeping quality.

Very satisfactory progress should be reported on this project for this year.

2. *Investigational Work With Irish Potatoes* (Mountain Station and Truck Station—C. D. Matthews, L. H. Nelson and S. C. Clapp).

(a) *Variety Testing* (Mountain Station).—The testing of varieties of Irish potatoes to determine the most desirable varieties for Western North Carolina conditions was continued this year with 20 varieties. The testing has been in progress for a sufficient length of time to afford this Division with the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

(b) *Variety Testing* (Truck Station).—Satisfactory progress should be reported on the work to determine the most desirable early varieties for Eastern North Carolina and the best varieties for the second crop.

(c) *Hill and Tuber Unit Selection Work* (Mountain Station).—The hill and tuber unit selection method of variety improvement is being employed in an attempt to produce strains of the best varieties with greater productivity and more desirable characters.

(d) *Cultural Practices* (Truck Station).—Work was conducted to determine the effects of different cultural practices on the yield of potatoes. Practices receiving consideration were:

(1) Width of rows.
(2) Distance apart in the rows.
(3) Freshly cut or stored cut seed.
(4) Effect of sprouting on yield.
(5) Cut versus uncut seed.

(e) *Testing the Value of Different Sources of Seed.*—Experiments were conducted to determine the comparative value of Maine-grown seed, second-crop seed produced in the Coastal Plain, and Western North Carolina seed in different stages of maturity as the most desirable seed for the early crop of Irish potatoes in Eastern North Carolina. This work has not been in existence a sufficient length of time to furnish conclusive results.

3. *Investigational Work With Cabbage* (Mountain Station—C. D. Matthews, L. H. Nelson and S. C. Clapp).

Variety Testing. — The testing of varieties of cabbage to determine the most desirable varieties for Western North Carolina was continued this year. The testing has been in progress for a sufficient length of time to afford this Division with the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

4. *Observation Garden* (Truck Station—C. D. Matthews and L. H. Nelson).

The all-year observation garden at the Truck Station, which has proven so valuable in the past in supplying information regarding varieties and planting dates of different vegetables for Eastern North Carolina was not continued throughout the year because of the lack of funds.

Respectfully submitted,

C. D. MATTHEWS,
Chief, Division of Horticulture.

Report of Horticulturist

To the Director:—I am submitting herewith the annual report of the investigational work of the Department of Horticulture conducted at the State College during the year ending July 1, 1921, all of which work derives its support from the Adams' Fund for original research.

Six projects dealing with genetic studies of our native muscadine grapes (Vitis rotundifolia) are still incomplete, as follows:

Project No. 4—Rotundifolia Grapes: Further studies of inheritance of sex.

Additional data to be included in a summary of inheritance ratios will be published at the first opportunity, and will practically complete this study. There is not sufficient matter to warrant separate publication.

Project No. 5—Rotundifolia Grapes: Inheritance of productivity. Considerable data yet to be secured.
Project No. 6—Rotundifolia Grapes: Inheritance of color. This project is almost completed as originally planned.
Project No. 7—Rotundifolia Grapes: Inheritance of size of fruits. Several important points have yet to be determined.
Project No. 8—Rotundifolia Grapes: A study of quality characters.
Project No. 9—Rotundifolia Grapes: Hybridization with other species.

The last-named project has constituted the center of interest during the year. Pedigree studies of varieties and hybrids of various species were made, and as a result, several series of crosses, each with its reciprocal cross to serve as a check, were planned, namely: (1) Crosses between Vitis rotundifolia and other pure species; (2) Crosses between Vitis rotundifolia and primary hybrid varieties of other species. The use of further attenuated hybrids to be made later. In pursuance of this plan, clusters in 169 bags were cross-pollinated, out of which 34 bags and 483 seeds were recovered, a very gratifying percentage of successes.

Considerable difficulty in securing ripe pollen was encountered because of the very late blooming period of Vitis rotundifolia, but this was overcome in part through the courtesy of Professor Richard Wellington of the New York Geneva Station, and Professor E. L. Lord of the Florida Station, each of whom sent us the necessary supply of pollen at different times. The forcing of vines under glass in order to secure pollen at an earlier date than normal is of some use, but does not reach extreme cases of seasonal differences. The ultimate result we hope to obtain from this work is the determination of a working scale of crossing to guide in subsequent breeding work with this species of grapes, and so far, we have met with much encouragement.

During the year three new projects have been outlined and submitted for approval as being worthy of investigation, namely:

Project No. 10—Genetic studies with Juglans regia, including methods of propagation.
Project No. 11—Prune type of Prunus species.
Project No. 12—Genetic studies with bramble fruits, especially raspberries.

It may be stated that subsequently approval was granted and active steps were taken to acquire additional stock for this work.

In closing this report, allow me to express my high appreciation of the ability and work of C. F. Williams, research assistant.

Respectfully,

J. P. PILLSBURY,
Horticulturist.

REPORT OF THE DIVISION OF PLANT PATHOLOGY AND BACTERIOLGY

To the Director:—This report of investigational work covers the fiscal year ending June 30, 1921.

As noted in the report of the previous year, work has been directed mainly along two lines, one of which includes a study of certain diseases of tobacco and the other of certain diseases of soybeans. Little progress has been made on these projects since sufficient funds have not been available to continue the field studies. Attention has been turned, therefore, to a less expensive line of investigation in which bacterial organisms from tobacco and soybeans have been employed in some fundamental studies on the physiology of plant pathogenic bacteria. These studies are concerned mainly with the influence of hydrogen ion concentration and should be completed for publication during the coming year.

The work on rust-resistant wheats in coöperation with the Division of Agronomy, has been continued. Rust infection has been unusually severe throughout the State, but the resistant varieties have remained remarkably free from rust. Although their yield compared very favorably during the past season with varieties adapted to this section, they are to be regarded as inferior. Additional varieties will be tested during the coming year in the hope that a variety may be found which is adapted to this section and is at the same time rust-resistant.

Studies on Phoma blight of soybean have been continued and are nearing completion. Very material progress has also been made in an investigation involving the treatment of seed-borne infections. Both of these studies should be completed for publication during the coming year.

PUBLICATIONS

The publications from the Division during the past year include the following:

1. Wolf, Frederick A. A little known vetch disease. Jour. Elisha Mitchell Soc. 36: 72-85, pls. 2-6, 1920.
2. Plummer, J. K., and Wolf, Frederick A. Borax injury to crops. Bul. N. C. Dept. Agr. 41: 15, 1-20, figs. 8, 1920.
3. Wolf, Frederick A., and Shunk, I. V. Solid culture media with a wide range of hydrogen and hydroxyl ion concentration. Jour. Bact. 6: 325-330, 1921.
4. Shunk, I. V., and Wolf, Frederick A. Further studies on bacterial blight of soybean. Phytopath. 11: 18-24, fig. 1, 1921.
5. Shunk, I. V. Notes on the flagellation of the nodule bacteria of leguminosæ. Juor. Bact. 6: 239-246, pl. 1, 1921.
6. Wolf, Frederick A., and Shunk, I. V. Tolerance to acids of certain bacterial plant pathogenes. Phytopath. 11: 244-250 tabs. 2, 1921.

7. Wolf, F. A., and Lehman, S. G. Notes on some new or little known plant diseases in North Carolina in 1920. N. C. Agr. Exp. Sta. Ann. Rept. 43: 55-58 (1920), 1921.

8. Lehman, S. G. Soft rot of pepper fruits. Phytopath. 11, 85-87, 1921.

9. Lehman, S. G. Penicillium spiculisporum, a new ascogenous fungus. Mycologia 12: 258-274, pl. 19, 1920.

Respectfully submitted,

FREDERICK A. WOLF,

Chief, Division of Plant Pathology.

REPORT OF THE DIVISION OF MARKETS AND RURAL ORGANIZATION

To the Director:—This report is for the year ending December 1, 1921, and covers the extension and service work in the Division of Markets and Rural Organization, conducted jointly or separately by the North Carolina Department of Agriculture and the North Carolina State College of Agriculture and Engineering, in coöperation with the United States Department of Agriculture under the agreements and plans entered into by these institutions for the conduct of all agricultural work of this kind in the State.

THE STATE WAREHOUSE SYSTEM

From September, 1920, to date, warehouses have been licensed under the State System as follows:

Aberdeen, 860 bales; Clinton, 2,000 bales; Chadbourn, 600 bales; Creedmoor, 300 bales; Dunn, 3,000 bales; Fairmont, 1,000; Fayetteville, 3,000 bales; Fayetteville, 1,000 bales; Jacksonville, 600 bales; Kelford, 500 bales; Kenly, 1,000 bales; LaGrange, 1,000 bales; Lilesville, 600 bales; Louisburg, 3,000 bales; Lumberton, 3,000 bales; Monroe, 5,000 bales; Moncure, 600 bales; Morven, 1,500 bales; Marshville, 500 bales; Maysville, 125 bales; Oriental, 500 bales; Pee Dee, 200 bales; Polkton, 600 bales; Plymouth, 1,000 bales; Pollocksville, 500 bales; Red Springs, 2,500 bales; Richlands, 1,000 bales; Sanford, 1,500 bales; Selma, 600 bales; Smithfield, 7,000 bales; Spring Hope, 500 bales; Swan Station, 450 bales; Wadesboro, 350 bales; Waxhaw, 250 bales; Weldon, 600 bales; Whiteville, 400 bales. Totals, 36 warehouses, 47,135 bales capacity.

Of the above warehouses, Chadbourn, Plymouth, Sanford, Swan Station and Whiteville did not renew their licenses, while licenses are pending for warehouses at New Bern and Windsor, making a total of 32 warehouses at present in the State System.

The Warehouse Law, as amended by the recent regular session, made necessary important changes in the form of negotiable receipt.

Until recently, the cotton on storage was insured under specific policies taken out by the local managers. This arrangement was open to grave objections, chief among which were (1) with slight changes in price, there was danger of the cotton being caught underinsured, and (2) the necessary and unavoidable overinsurance, amounting to about ten per cent, was a heavy expense to the warehouses. To remedy these and other difficulties, policies, effective November 1, 1921, were secured from the 11 North Carolina insurance companies, which were automatic in nature. These policies are held by the State warehouse superintendent, and provide that the cotton is automatically insured when it is received for storage, and the insurance automatically ceases when the cotton is delivered from storage. Premiums are paid monthly. It is

calculated that the total saving to licensed warehouses will amount to at least 35 per cent reduction below the regular rates.

Under section six (6) of the Warehouse Act, requiring all gins in the State to be licensed, there have been licensed 1,819 gins. According to records from the office of the Commissioner of Revenue, 400 gins have failed to apply for license. These have been notified on several occasions, the most recent being a notice from the Attorney-General to the effect that legal proceedings would be instituted in case of continued failure to comply with the law.

The Warehouse Fund at present amounts to nearly $500,000. Of this amount, $147,500 are invested in North Carolina bonds, and $7,850 in United States bonds, while the loans to warehouses are as follows:

Farmers Union of Jones County, Pollocksville	$ 1,000
Kelford Warehouse Company, Inc., Kelford	700
Kenly Cotton Oil and Storage Company, Inc., Kenly	17,500
Fidelity Cotton Warehouse Company, Fayetteville	24,000
Robeson Warehouse Company, Lumberton	25,000
Red Springs Bonded Warehouse Company, Red Springs	8,000
Union County Warehouse Company, Monroe	31,000
Victory Gin Company, Kings Mountain	5,000
Moncure Farmers Cotton Warehouse Company, Moncure	1,500
Farmers Cotton Warehouse, Inc., Smithfield	47,500
Sampson Cotton Warehouse Company, Clinton	25,000
General Utility Company, Dunn	70,000

At present there is on hand for loans $55,000, of which $4,000 has been promised to the Victory Gin Company, of Kings Mountain, and $46,000 to the General Utility Company, of Dunn, leaving $5,000 available. There is available $27,000 to be invested in bonds.

The Interest Fund, available under the law for the administration expense of the State Warehouse System, amounted on December 1 to $4,736.75. The anticipated income from this source for the ensuing year amounts to $18,000.

COTTON CLASSING AND GRADING

The work has the following objects in view: To interpret market conditions to the producer, and to demonstrate to him the advantages of having a correct knowledge of the value of his product so that he may market it intelligently. Very often we help the producer market his cotton, although in those cases we only act as an agent between the buyer and the seller. In acting in this capacity, it is very easy to demonstrate the correct method in marketing cotton to a street buyer.

To encourage the selecting and planting of a better variety of seed which is best adapted to that specific community, by acquainting the producers with the premiums being paid for the better qualities of cotton.

To encourage care in gathering and ginning by explaining the cause of the low grades and acquainting the producer with the wide discount at which they sell.

To encourage the proper storing of cotton and the building of more and better warehouses, by bringing to their attention the enormous waste suffered each year on account of weather damage, and to the discount in price buyers make on cotton that has been reconditioned.

Our procedure for this year is as follows:

Instead of a classer serving any one town or small community, as they do in other states, in this State we serve a whole county with one classer. For any county to secure the services of this classer, they contribute the sum of $750 toward his salary and expenses. This appropriation is generally made through the county commissioners. However, this is not compulsory, as the appropriation may be made in any other way. The classer is stationed at the county seat. One of the first duties of the classer, after he has opened his office and advertised the fact through the local newspapers, is to make a thorough canvass of the county, call on all producers, acquainting them with the work, and also explaining in detail, so that they may take advantage of same. This is done generally by furnishing the producer with supplies for his use in sending samples to the classing office for classification. These supplies consist of cotton tags with coupons attached (the tag is attached to the bale and coupon, with name and address of owner, is wrapped inside sample, which is to identify the corresponding bale of cotton), paper wrappers for wrapping each sample, and bags to be used as containers. Upon the arrival of these samples at the classing office, they are immediately classed, and certificate, showing grade and staple, is mailed to the owner. This explains the method of grading cotton that is not marketed in the town at which the grader is stationed. On cotton that is marketed in the town at which the grader is stationed, the owner brings samples to the classer's office and it is classed just before sale.

The classers at various times publish articles in the local newspapers relative to some phase of their work, and articles of interest to the cotton producers are at various times sent from the Raleigh office and published in the leading newspapers and farm journals of the State.

Another feature of our work is a weekly price report issued at the Raleigh office every Monday morning and sent to approximately 800 cotton producers throughout the State. The bulletin gives prices and differences between grades at various markets in the State, also prices from the large cotton centers in the belt. This bulletin is always headed with an article in regard to the situation, giving export and consumptive figures. In addition to the regular mailing list each classing office is furnished a supply of these bulletins, which are distributed to those visiting the office if they have not already received one by mail. This weekly price report is of great benefit to the producer, as it enables him to keep in touch with other markets, and to compare his market with adjacent markets.

This office, coöperating with the North Carolina State College of Agriculture and Engineering, conducted a six-weeks' school in cotton classing

in June and July of this year. There was a total enrollment of 34 for this class. Four hours a day were devoted to practice work and one hour a day to lectures. P. H. Hart had charge of the school, and was ably assisted by Jas. I. Johnson, one of our local classers, and N. H. Darst, of the college, who were, at various times, assisted by members of the extension service, the college and others. During this course, they examined and classed approximately 7,000 cotton samples of all grades and staples.

In addition to our regular State graders, special graders were examined and appointed at the following places for the purpose of grading cotton stored in warehouses operating under the State Warehouse System: Fayetteville, Lumberton, Fairmont, Monroe, Dunn, Smithfield, Sanford, Aberdeen, Clinton and Oriental. Cotton grading offices were established at the following places for the cotton season of 1920-1921: Raleigh, Clinton, Tarboro, Monroe, Wadesboro, New Bern and Smithfield.

The following is the number of bales classed by each office for the remainder of the season, beginning December 1: Raleigh, 6,190; Wadesboro, 7,616; New Bern, 12,465; Monroe, 6,274; Smithfield, 7,016; Tarboro, 6,995; Clinton, 2,585. Total for the remainder of this cotton season, 49,141 bales.

The following offices are established for the cotton season of 1921-1922: Raleigh, Greenville, Wadesboro, New Bern and Windsor. This report only covers three months of this season, September, October and November. The number of bales classed by each office for these three months is: Raleigh, 4,252; Wadesboro, 3,334; New Bern, 4,221; Greenville, 1,857; Windsor, 1,441. Total all offices for the three months, 15,105 bales.

The total number of bales classed by all offices for the entire year, 64,246 bales.

There are numerous letters on file received from the various producers throughout the State who have taken advantage of this service, expressing their approval and appreciation for services rendered.

WAREHOUSE CONSTRUCTION

Numerous inquiries received from all over the State indicate that interest in cotton warehouse development is active even though construction projects have been held back by reason of the financial stringency and later rise in the price of cotton. By reason of this situation and the present formative stage of the marketing association the services of our engineer, J. M. Workman, have been directed largely toward a survey of the State, aimed to determine the actual and relative advantages of 300 towns as marketing and storage centers for cotton. This study is designed as a guide to the marketing association, and to the most intelligent application of State aid and loan funds. It takes into consideration existing trade connections, variety and density of cotton production and its distribution, highways and transportation facilities,

financial institutions, and fire protection ratings. It is recognized that development in intelligent and truly economical production must reinforce all marketing accomplishments.

The two warehouses in process of construction are located at Kings Mountain and at Dunn and have an aggregate capacity of 10,000 bales. Both are being constructed with the aid of State loans, and in accordance with plans engineered by the Division of Markets. Inquiries indicate that a number of warehouse organizations will be launched in the spring.

WAREHOUSE ORGANIZATION

T. B. Parker, having charge of the organization work in connection with warehouse construction, reports as follows:

"On account of financial conditions this has been largely a year of office work rather than field activities, therefore actual warehouse construction has been at a low ebb. This was made necessary on account of financial conditions confronting us.

"After attending the 'Acreage Reduction' conference at Memphis, where cotton storage warehouses as an adjunct to the cotton-holding movement was discussed and endorsed; and, after visiting Sanford, in this State, where I discussed the value of cotton storage warehouses, but without effecting an organization; and Elizabeth City, where I met a delegation of farmers and talked over the warehouse situation with them, which may some time result in the building of a warehouse at that place; and visiting Kelford, where I discussed the financial situation with patrons of the warehouse at that place, I was advised that our financial condition made it necessary to cut out all travel possible, and otherwise cut down expenses to the minimum, which I did.

"However, when the call came for workers in the coöperative marketing campaign, I responded and made three trips to Johnston County, and also spent about a week in Franklin County, where I spoke on cooperative marketing. I also made trips to Alexander, Lincoln and Iredell counties in the interest of coöperative marketing. My next out-of-town activities were at community fairs, where I acted as judge of exhibits. In the meantime, however, I had inquired in regard to the building of cotton storage warehouses, which I advised against except for temporary purposes until the marketing association begins to function and we can better decide as to the best locations for permanent storage warehouses with a view to convenience to the largest number of shippers and as profitable investment. At the same time I suggested the use of temporary warehouses such as tobacco warehouses and other substitutes until we could see our way more clearly as to the best locations for permanent warehouses. I do not think the time has yet arrived, nor will arrive, for the location of expensive permanent warehouses until the Coöperative Marketing Association begins to function and we coöperate with it in respect to the best locations for warehouses. But I think we should wage a campaign for the storage of cotton now,

in temporary warehouses, where it will be protected from weather damage, and enjoy the benefits to be derived from our warehouse system until there shall be an advance in prices that will justify the farmers in putting it on the market.

"It was my desire to visit each cotton storage warehouse this past year and, among other things, discuss the situation with managers and patrons, so as to get their views and suggestions along lines that might be helpful to us in laying out our work and in forming plans and regulations for the future, but our financial condition precluded such visits. However, I am hoping that another year will place us in condition to make these visits that I may see more of the actual operations of our storage warehouses, and in that way get a better insight into their workings."

FRUITS AND VEGETABLES

Organizations

After careful investigation it seemed very evident that the truck growers around Mount Olive were really in earnest in their demand for coöperative marketing, so the organization and incorporation of the Mount Olive Truckers' Association was completed. Fortunately, the growers were able to secure as manager a man with broad experience and with a keen determination to sell only first class stock, carefully graded and honestly packed. To offset the shortage of machine sizers in the potato field, a sizer was placed in a grading shed along the tracks at Mount Olive. The season was really a success despite the fact that the directors made the mistake of taking in, after the season began, more members than they were equipped to care for. The most of the members are highly satisfied but believe it best to reorganize under the new Coöperative Law in order to secure the additional protection afforded by it. They also desire to increase the territory served, taking in perhaps Dudley, Calypso and Faison this coming season. They plan to handle practically all kinds of truck, aside from cantaloupes. The latter they have found to be a source of trouble, especially in seasons with weather conditions similar to those of 1921. A new set of by-laws and a series of crop-marketing agreements are now being prepared by the Division for their use.

The Scotland County Coöperative Cantaloupe Exchange was organized largely on the initiative of its members, although this office was asked for assistance in preparing an application for a charter for incorporation under the new coöperative law They had for sale this season around 200,000 crates of Rocky Ford cantaloupes, and they appointed inspectors to see that every package was carefully gathered, correctly graded and properly packed. The association guaranteed an honest pack, grade and count.

A similar organization was anticipated by one or two of the cantaloupe growers near Fayetteville, but after careful investigation, it was

very evident that the growers themselves did not manifest enough interest in such a proposition to insure success, and so the parties were advised to wait for another season before attempting an organization. In the meantime they will carry on an educational program and attempt to mould public sentiment in favor of the coöperative effort. It has been the opinion of this Division that it is just as important to advise against organization where such seems untimely, as it is to render assistance in organization where the prospects are the best.

In an effort to solve some of the sweet potato marketing problems of this section, an organization of sweet potato growers was formed at Rocky Mount. The bulk of the storage crop of Nash and Edgecombe counties was signed up for this association, and a subsidiary storage corporation for handling the potatoes of growers not owning storage was formed. Both the association and the storage companies are organized under the laws of this State, and the storage company exists merely for the purpose of serving the association. This deal has been modeled largely after the California plan, and this office has assisted principally in preparing the growers' agreement and cross contract between the association and its local warehouse companies. Similar organizations will be formed at other points in the State as conditions warrant, and all under similar contracts, so that it will be easy to federate all into one large central sales organization.

Standardization of Grades and Packages

The grades previously adopted for legal standards in this State have been continued in effect. A careful study was made this year of grades for cucumbers and peaches, with an idea of standardizing them next season. The grades for cucumbers, recommended by the Bureau of Markets, were adopted as the standard by the Mount Olive Truckers' Association this season, and were found very satisfactory. The Mount Olive section shipped as high as forty cars of cucumbers in a single day. The grades recommended by the Bureau of Markets for peaches were modified slightly to suit the needs of the Sandhill Fruit Growers' Association, with headquarters at Aberdeen. They had about 700 carloads of peaches this year and employed an expert packer from Georgia to supervise the grading and inspection work. They used the grades on their crop of Belle of Georgia and Elbertas, their early varieties being excluded this season because they were unable to put the grades into operation so soon. We believe, judging from this year's experience, that with only minor changes, the United States peach grades will be readily adaptable to the North Carolina crop.

The strawberry grades were enforced in both leading strawberry sections this season, and as a result North Carolina strawberries sold as well as those from any other section on the Northern markets. The deceptive pack has been eliminated to a large extent, and public sentiment alone, within a year or two, will be sufficient to prevent a return to the

old system. The grades for potatoes and sweet potatoes are being continued, but a serious shortage of funds has limited the field work to a very large extent.

Considerable improvement has been made in the grading and packing of all fruits and vegetables as a result of our work under the State Grading Law in the enforcement of grades for potatoes, sweet potatoes, strawberries and apples. In all our work with enforcement of State law on grades, we have endeavored to be lenient and to proceed slowly. The work has been largely educational, and we find we secure best results by personal work with the larger growers, explaining to them the serious needs for this work. In this way it takes only a season or so to create an overwhelming public sentiment in favor of the improved practices, and deceptive packing is now very unusual in the sections in which we have worked, although three years ago it was a general rule.

Little work has been done in the line with standardizing packages, although we have repeatedly recommended to individual growers the need for standardization along this line.

Dissemination of Market Information

In coöperation with the Federal Bureau of Markets, this Division supplied the men for operating the Strawberry Daily Market Reports from Chadbourn again this season. The season was unusually early and quite short. It was a very successful one for the growers. Good quality stock averaged around $5.75 to $6.00 per 32-quart crate. Shipments this year were 476 cars, as compared with 446 last season, and judging from the new acreage now being set, we may expect from 600 to 700 cars next season. Eighteen daily reports and a summary were mailed to a list of about 400 growers.

The apple grading and packing schools planned for the western counties were not held this season on account of the almost total failure of the apple crop, and the only exhibit made was in connection with the Crop Reporting Service of this Division at the State Fair.

AGRICULTURAL STATISTICS, CROP REPORTING SERVICE

The report of Frank Parker, Agricultural Statistician, follows:

The present year has been one of growth in the State's statistical phase of agricultural economics—this in the face of added responsibilities, change of quarters and environment. The demand for and appreciation of this form of information has been the best evidence of its worth-whileness, industrial agencies having offered to supplement our funds.

A mass of data would be tiresome, so suffice it to say that the Cooperative Crop Reporting Service, even with deficient funds, has handled 150,000 pieces of mail; prepared an average of three reports a week, the whole involving millions of calculations and responsibility for their accuracy.

Crop statistics, so definite in its meaning, has caught the interest of all. The marketing field has recognized this deficiency in their information. They and the public want to know the marketing statistical trend. The Marketing Division, the Extension Service, and the State newspapers are greatly interested in getting it developed. The Board in May combined the marketing and statistical work for the purpose of building up the marketing statistical service.

PUBLICATIONS

There are 270,000 farms in North Carolina. Each operator should benefit by the satisfaction of knowing crop and market trends. This information is available, but not the means of getting it to them. Printed results presented in simple and comparable form are essential to this end. It will be like preparing for, planting, cultivating and harvesting a crop and using but little of it, to continue as we do now.

CREDIT UNIONS

There are 33 credit unions in the State of North Carolina. No new unions were organized during the past year, but six are now being organized. Most of the unions have suffered from the slump in the prices of farm products. In only a few of the unions have deposits amounted to much. The chief business of the credit unions this year has been borrowing from the banks and lending to the members. Because of the bad crops and low prices, loans in some of the unions have not been repaid promptly. But the credit committees have pursued the policy of requiring all notes not met when due to be renewed, and new endorsements given where necessary. The credit union work can be most aptly described as having been at a standstill during the past year.

But in nearly every community where the credit unions have been in operation the members unanimously agree that the unions are indispensable for meeting the farmers' financial needs. In two of the unions meetings were called for the purpose of considering dissolution, but after the matter was thoroughly discussed, both unions voted unanimously to continue. In ten unions the secretary-treasurers report that the unions were able to borrow funds last year when it was impossible for the members to borrow as individual farmers.

Where the bankers are acquainted with the credit unions, their purposes and their work, the unions seem to have no trouble in borrowing all the funds they need. Bankers interviewed in several counties where credit unions are in operation stated that they preferred making loans to farmers through their unions rather than to farmers individually. But in some of the towns the bankers seem to be unaware that there is a law providing for credit unions. In these sections, where farm supplies are bought largely on time, the credit unions must depend on the

banks to furnish them loans. It is highly important that the bankers become acquainted with the work of the unions, and that mutual confidence and coöperation between unions and banks be established.

The unions are doing their most effective work in those communities where there are no banks convenient, and among those farmers without banking connections, who need to borrow money. In the little town of Valdese, which has no bank, its credit union has become a veritable bank in every respect. The unions are proving to be unusually helpful among the colored farmers in Wake, Columbus and Johnston counties. The colored farmers, as a rule, have no banking connections. The credit unions, chiefly under the direction of their local agricultural agents, have served as agencies for getting credit from the banks. The coöperative buying of fertilizers and food and feed supplies has become quite an important part of the work of the credit unions among the colored farmers.

About two-thirds of the unions have gone ahead with their usual business during the last year. The other third has marked time, some of them doing practically no business during the last year.

Less than half the unions have been sending in their regular monthly reports since January 1, 1921. Only seven of the 33 unions made the annual report required by law last January.

In seven of the 13 unions visited since September 15, 1921, the books of accounts were found to be poorly kept or out of balance. Keeping the accounts seems to be one of the most difficult parts of operating the credit unions.

The members of the unions have missed very much the *Credit Union News* The discontinuance of this sheet seems to have had a bad psychological effect on the members, in that they got the impression that the work in other unions was lagging.

Respectfully submitted,

B. F. BROWN,

Chief, Division of Markets and Rural Organization,
State Superintendent of Warehouses.

REPORT ON FARM DRAINAGE

To the Director:—I herewith submit the annual report on drainage conducted under a coöperative agreement between the North Carolina Department of Agriculture and the United States Department of Agriculture. This report covers the crop year November 20, 1920, to November 30, 1921.

The drainage division suffered the loss by death on May 17, 1921, of H. M. Lynde, Senior Drainage Engineer, Bureau of Public Roads, United States Department of Agriculture, who has been in charge of this work. The writer has been in charge of the work since his death, and was transferred from the North Carolina Department of Agriculture to the Bureau of Public Roads, United States Department of Agriculture, as drainage engineer, on August 2, 1921. Since May 17, 1921, the office has had but one man available for carrying on its projects.

The work has been conducted chiefly along the same lines as in previous years. In general, the extension part of our program consists (1) in assisting farmers in the improvement by drainage and terracing of lands now under cultivation, and (2) in making preliminary and reconnaissance examinations for drainage districts desiring to make drainage improvements.

Upon request, either from the county agent or the farmer, the drainage engineer makes preliminary examinations, surveys, designs, estimates, specifications and reports for tile drainage projects on the farm. A blue-print is sent to the farmer, showing the complete system of drains. When the farmer is ready to install the tile, certain drains are staked out in the field and instructions given in the proper methods of construction.

Terraces are laid off in entire fields, and instruction is given in the use of the farm level and in terrace construction. The elementary principles of the use of the farm level in terrace location are taught at boys' club encampments. County agents in the counties needing terraces are instructed in methods of terrace location and construction, and the levels used in this work are tested and adjusted by the engineers of this office.

The engineer also makes preliminary examinations of drainage districts. The proposed district is visited and from all available data a report is prepared, accompanied by a map, copies of which are furnished to interested parties. The method of organizing a district under the State Drainage Law is outlined. The following summary gives a fairly accurate idea of the amount of work done along these lines:

FARM DRAINAGE

During the past twelve months, 33 farms, situated in 17 counties, have been visited for the purpose of giving assistance and advice in tile drainage. The areas of these tracts ranged from 4 to 1,820 acres, with a total

area of about 3,300 acres. Preliminary surveys for tile drainage have been made and reports issued on 12 farms, with a total area of 2,528 acres. Stakes and grades for construction have been given on 10 farms for the installation of 35,790 feet of tile, approximately 7 miles.

One hundred and eleven farms, situated in 21 counties, have been visited for the purpose of giving assistance in the location and construction of terraces to prevent hillside erosion, the total length of terraces laid out being approximately 284,500 feet, or 54 miles.

Drainage Districts

Eleven examinations of a preliminary or reconnaissance nature have been made and reports issued covering an area of 52,450 acres.

Miscellaneous

The results of experimental work and other general information have been published from time to time in the *Extension Farm News,* and publicity given in other ways. Mr. Lynde addressed the southern section of the American Society of Agricultural Engineers at Lexington, Ky., on the experimental work done by this office, and visited Ohio and Indiana, studying drainage problems there. The engineers also attended the North Carolina State Drainage Association Convention at Elizabeth City, N. C., and discussed tile drainage and drainage district problems. Information was given to interested parties regarding drainage conditions in this State, including engineers, representatives from the United States Census, and corporations and individuals interested in drained or swamp lands of the State. A special report was issued on the causes of silt deposition on Second Broad River, Rutherford County. Studies were made on building arrangement and landscape design for two farmsteads.

The past year has been notable for the amount of work directed toward the prevention of erosion. The calls on the engineers of this office have been steadily increasing year by year for the purpose of locating and giving demonstrations in terracing. Notwithstanding the rather high prices of tile during the greater part of the year, there has been a considerable increase in the amount of tile installed. Both the number of drainage districts examined and the acreage covered by these districts has increased over the report of last year.

Respectfully submitted,

F. O. BARTEL,
Drainage Engineer.